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Devices for Measuring Rates and Amounts of Runoff (IV)

EMPLOYED IN SOIL CONSERVATION RESEARCH

Compiled for
Latin American Trainees

By

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This publication has been prepared expressly for Latin American trainees studying soil and water conservation in the United States. On these pages are condensed descriptions, illustrations and plans of runoff measuring devices used by the Soil Conservation Service in soil and water conservation research. Detailed information of the procedures employed in the collection and compilation of data as well as large scale drawings of the illustrations are available to trainees on request. We hope that information contained in this publication will aid the trainees in whatever soil conservation work they may later undertake in their respective countries

H. H. Bennett

H. H. Bennett, Chief
Soil Conservation Service

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INTRODUCTION

Research investigations in soil and water conservation conducted by the U. S. Soil Conservation Service involve the determination of rates and amounts of runoff produced by precipitation on small plots and on natural drainage basins ranging in size from one or two acres to several thousand acres.

Runoff from plots and the smaller drainage basins is nearly always produced by intense rainfall. In practically all cases the flow is intermittent. Rates of runoff increase rapidly from zero to the maximum, the maximum rates usually last only a few minutes, and the flow ceases soon after the end of precipitation. Runoff from agricultural areas often carries considerable amounts of floating debris and eroded material. Measuring devices such as sharp-crested weirs and the standard current-meter procedure, developed many years ago, were found to be inadequate for the measurement of runoff under conditions described above. It was necessary, therefore, to develop devices and adopt procedures specifically suited for the work of the Service. All flows from plots where rates are desired, and all flows from smaller basins as well as low flows from the larger basins, are measured by means of flumes and special weirs developed and calibrated in hydraulic laboratories. Where only total amounts of runoff from small plots are desired, measurement is accomplished by collecting the entire flow or an aliquot of it in calibrated tanks. The aliquot device known as the multislot (Geib) divisor is commonly used on plots of soil and water conservation experiment stations.

The standard current-meter procedure, fully described in U. S. Geological Survey Water Supply Paper 888, has been adopted for calibrating the runoff stations for larger areas where the flow is comparatively large and maximum rates persist long enough to permit its use (plate 1).

In all cases a continuous record of depth of flow (stage or head) is obtained by means of water-level recorders. The water-level recorder FW-1, manufactured by the Julien P. Friez & Sons Company of Baltimore, Maryland and described in their catalogs, was developed for the work of the Soil Conservation Service and is used on practically all of its runoff measuring installations. A procedure for setting water-level recorders on flumes and weirs is given on page 13.

The stage records from the water-level recorders are converted into rates of flow by means of laboratory rating tables developed for each type of runoff measuring device, or by means of the current-meter calibrations for the larger areas. Total runoff for an entire runoff period or any portion of it is obtained by integrating the rates of flow during the period.

Brief descriptions of the runoff measuring devices most widely used in Soil Conservation Service Research follow:

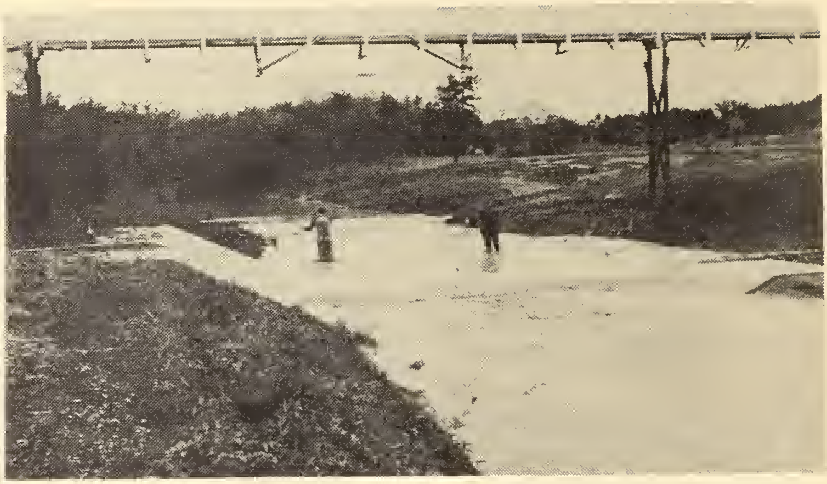
HS, H AND HL TYPE FLUMES

The HS, H and HL type flumes developed by the Soil Conservation Service consist of converging vertical side walls cut back on a slope at the outlet so as to give a trapezoidal projection of the outlet. With these types of flumes where the throat width increases as the depth of water increases, accurate measurements of the small as well as the large flows are obtained. The various dimensions of each flume are proportional to the depth of the flume. For example, the bottom throat width of the HS type flume is 0.05 times its depth, or 0.02 feet for a 0.4 foot HS flume. Likewise the bottom throat width of the H type flume is 0.1 times its depth, or 0.3 feet for a 3-foot H flume. Also the bottom throat width of the HL type flume is 0.2 times its depth, or 0.8 feet for a 4-foot HL flume. The maximum rate of flow for the various flumes for which calibrations are available is given in table 1.

The grade of the approach channel may be as high as 3 percent without affecting the calibration of these flumes. Sloping floors (1 on 8), designed to concentrate the flow along the side of the flume on which the well intake openings are located, decrease the deposition of suspended material at these openings. The difference between the calibration of a flume with a sloping floor and that with a flat floor is less than 1 percent. Submergence of 30 percent increases the head only 1 percent. For the effect of higher degrees of submergence see figure 1. Riveted joints are preferred to welded joints because the latter cause excessive heat distortion.

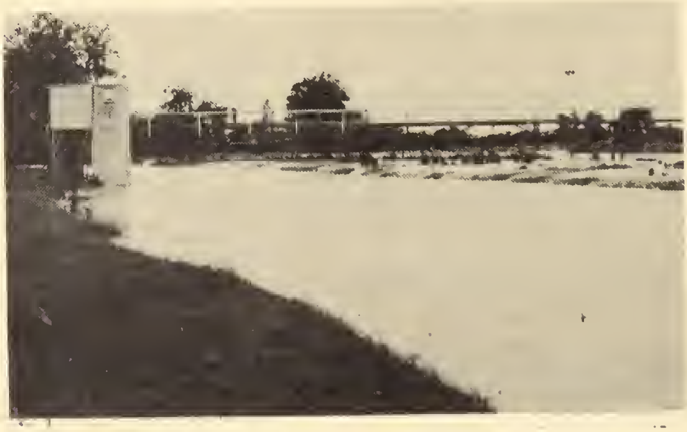
In flat areas, a flume installed with its floor flush with the ground surface would cause excessive ponding. If this artificial pondage is larger than that under natural conditions of flow, values of maximum rates of runoff and the shape of the hydrograph will be materially affected. The amount of the artificial pondage can be reduced by lowering the flume and installing a drop box in the approach to the flume as illustrated in figure 12 and plate 2,E.

Waco, Tex. 20214



A, Current-meter station; calibrated weir partly submerged in foreground; drainage area 4,380 acres.

Waco, Tex. 20548



B, Current-meter station; calibrated weir for low flows completely submerged; drainage area 5,860 acres.

Table 1. - Rates of flow, cubic feet per second for HS, H and HL flumes for various water depths (head), feet

Flume	Water depth - (feet)												
	0.05	.10	.20	.40	.6	.8	1.0	1.5	2.0	2.5	3.0	4.0	4.5
Feet													
HS													
0.4	0.000982	0.00417	0.0179	0.0851	-	-	-	-	-	-	-	-	-
.6	.00138	.00517	.0207	.0918	0.229	-	-	-	-	-	-	-	-
.8	.00174	.00625	.0237	.100	.245	0.470	-	-	-	-	-	-	-
1.0	.00209	.00736	.0270	.109	.261	.495	0.821	-	-	-	-	-	-
H													
0.5	.0024	.0101	.0431	.204	-	-	-	-	-	-	-	-	-
.75	.0032	.0126	.0501	.224	.566	-	-	-	-	-	-	-	-
1.0	.0040	.0150	.0571	.244	.598	1.16	1.96	-	-	-	-	-	-
1.5	.0057	.0200	.0711	.283	.672	1.27	2.09	5.41	-	-	-	-	-
2.0	.0073	.0248	.0850	.323	.745	1.38	2.25	5.65	11.1	-	-	-	-
2.5	.0089	.0298	.0990	.363	.818	1.49	2.41	5.91	11.5	19.4	-	-	-
3.0	.0105	.0347	.113	.403	.892	1.61	2.58	6.24	11.9	20.1	31.0	-	-
4.5	.0154	.0496	.155	.520	1.11	1.94	3.04	7.07	13.2	21.6	32.7	63.9	84.5
HL													
4.0	.029	.089	.278	.940	2.01	3.53	5.56	13.0	24.3	39.9	60.3	117.	

The HS-type flumes (figure 2), with maximum depths of 0.4, 0.6, 0.8 and 1.0 feet, are used to measure flows up to about 0.8 cubic foot per second and are employed mostly on small plots. Drawings (figures 3, 4 and 5), specifications (page 19), and ratings (table 2), are given in complete detail.

The H-type flumes (figure 6), with maximum depths of 0.5, 0.75, 1.0, 1.5, 2.0, 2.5, 3.0 and 4.5 feet, are used to measure flows from drainage basins where runoff rates in excess of 0.8 cubic foot per second may be expected and where the maximum rates probably will not exceed 80 cubic feet per second. Drawings (figures 7-10), specifications (page 26), and ratings (table 3), are given in complete detail. Photographs (plate 2) show field installations of H-type flumes.

The HL-type flumes (figure 11), with a maximum depth of 4 feet, are used to measure flow from drainage basins where runoff rates in excess of 80 cubic feet per second can be expected and where the maximum rates will probably not exceed 117 cubic feet per second. Rating for the 4-foot HL flume is given in table 4.

PARSHALL FLUMES

Parshall flumes[1], long used in irrigation canals where the flow is relatively constant for long periods, are rectangular in cross section. Large flumes of this type are, therefore, not sensitive enough to measure low flows adequately. Large Parshall flumes are, however, used in conjunction with flumes of smaller throat width or with auxiliary precalibrated weirs (plate 3) which provide adequate measurement of low flows. This requires the use of two water-level recorders.

TRIANGULAR WEIRS

Triangular weirs with 2 to 1, 3 to 1, and 5 to 1 side slopes were developed by the Soil Conservation Service for measuring flows up to about 1,000 cubic feet per second.

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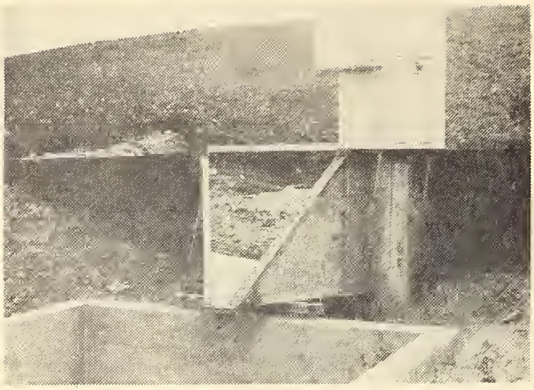
[1] The characteristics of these flumes are described and calibrations are given in "Parshall Flumes of Large Size", Bulletin 386, Colorado Agricultural Experiment Station, May 1932; and "The Parshall Measuring Flumes", Bulletin 423, Colorado Agricultural Experiment Station, Fort Collins, Colorado, March 1936 by R. L. Parshall.

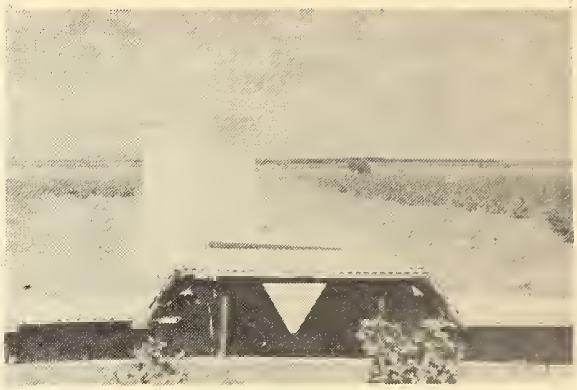
Coshocton, Ohio 21410

Plate 2



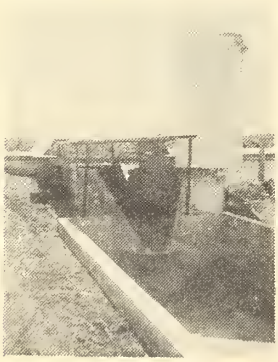
A, H type flume, stilling well, and recorder shelter box for catching sediments shown in foreground.

Waco, Tex. 20311



B, H type flume, gutter, drop box, recorder shelter. Cover on flume, gutter and drop box prevents rain from falling on these impervious surfaces and running off through the measuring flume.

Waco, Tex. 20313

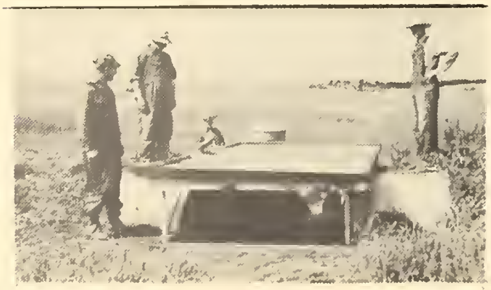


C, H type flume, gutter, and recorder shelter; drop box approach. Concrete flume with angle iron edges.

Hastings, Nebr. 23389

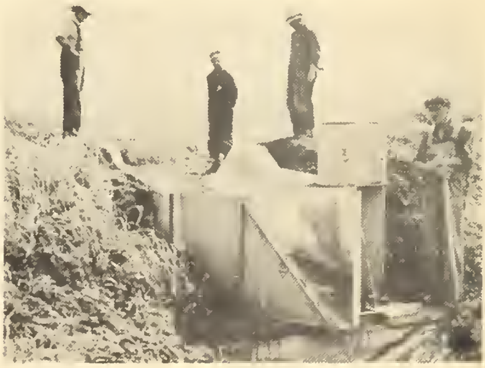
D, H type flume and recorder shelter.

Hastings, Neb. 23514



E, H type flume with drop approach box. Cover prevents rain from falling on impervious surfaces and running off through the measuring flume. Snow drifts in flume and approach box also reduced by cover.

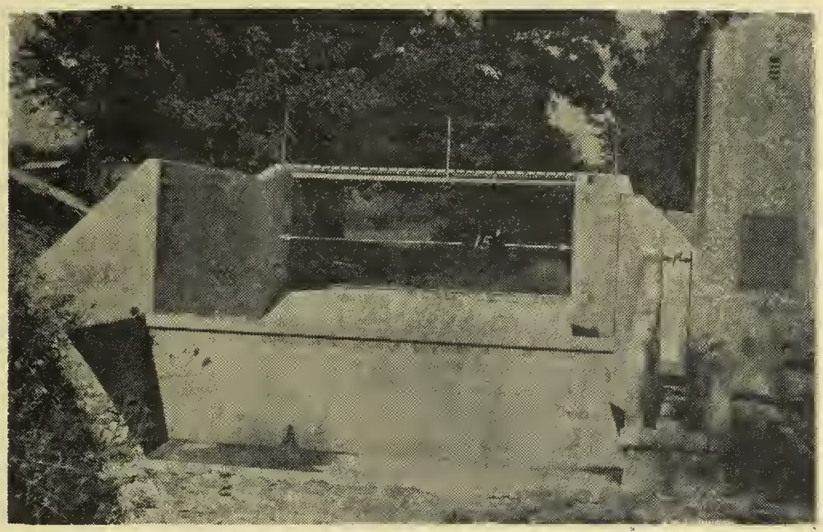
Hastings, Nebr. 23516



F, H flume with drop approach box and recorder shelter. Cover removed.

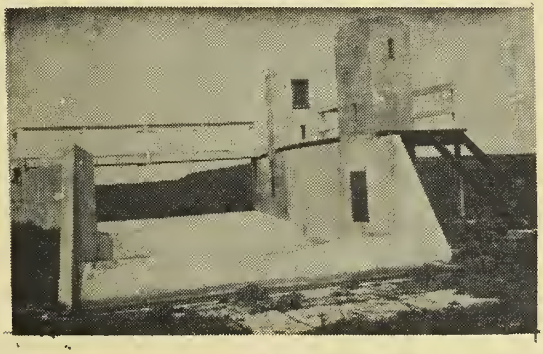
Plate 3

Coshocton, Ohio 21331



A, Large (15-foot) Parshall flume with small (1-foot) supplemental Parshall flume for low flows.

Waco, Tex. 20235



B, Large (10-foot) Parshall flume with supplemental ogee 5 to 1 weir for low flows.

These weirs consist of concrete V notch dams 16 inches thick[2] with trapezoidal crests shaped as shown in figure 13. The triangular shape of these weirs affords measurement of small and large flows with comparable degrees of accuracy. The shape and thickness of the crest permit comparatively free passage of debris and minimize the effect on the stage-discharge relationship of small irregularities of the crest and of trash temporarily lodged on the crest. Channel slopes in excess of 2 percent and irregularities in the channels of approach induce velocities which seriously affect the calibrations. Where the weirs are installed in well defined constricted waterways (plate 4), it is essential to insure that the channels of approach are reasonably straight and practically level for a distance of at least 50 feet above the weir. The weirs may be constructed with the apex of the notch either flush with or above the upstream channel. It is advisable, however, to keep to a minimum the amount of water impounded below the apex of the notch (plate 5), in order that a complete record of flow may be obtained without resorting to pondage computations which are rather involved and cannot be made with a high degree of accuracy. In case of constricted waterways, better results can be obtained by lining the channel of approach for a distance of about 50 feet so that the bottom of the channel is level and flush with the apex of the notch, and the side slopes are flatter than the side slopes of the weir.

The laboratory tests indicate no appreciable effect on the calibrations of submergence up to 50 percent. Most of the installations now in use have been designed for free flow. The height of the notch in practically all cases is 2 feet above the downstream apron, and the downstream channels have ample capacity to carry the maximum flows to be expected. It is often necessary to measure runoff from drainage basins with wide, shallow, and poorly defined watercourses. Under such conditions the flow has to be confined and diverted into the weirs by means of earth dikes or training walls (plate 6). This creates unnatural pondage at high stages which affects the rates of flow and the shape of the runoff hydrographs. An approximate method has been developed whereby the rates of runoff are corrected in extreme cases. The magnitude of this correction is determined by the surface area of the pond created by the weir and the rate of change in stage. In view of the uncertainties involved in this correction it is preferable to avoid installations with excessive pondage or, if possible, to provide approach boxes similar to those mentioned above for the type HS, H and HL flumes. Such boxes on the weirs would necessarily have to be considerably longer than those used with the flumes.

The triangular weirs are capable of satisfactorily measuring flows with reasonable amounts of suspended erosional debris. They should not, however, be used where heavy bed loads may be expected. Under such conditions devices which accelerate rather than retard the flow must be used in order that the material brought to the measuring section may be carried through it. Trapezoidal channels on steep slopes are being tried on some installations (plate 7,A) where heavy bed load is encountered, but no conclusive results have yet been obtained.

The intakes to the stilling wells housing the floats of the water-level recorders must be 10 feet upstream from the center of the crest, as the laboratory calibrations are based on measurements made at this distance. To eliminate interference with the flow, the stilling well must be set back from the channel at least as far as the upper edge of the notch (plates 4, 5 and 6). Slots 1 inch wide and 6 inches long and overlapping 1 inch, cut in the channel side of the stilling wells, are used to equalize the water level inside and outside the stilling well (plates 4 and 6).

Although the height of the apex of the notch above the bottom of the approach channel in itself has no effect on the calibration of the weir, the calibrations were found to depend on the cross-sectional area of the channel of approach at the point where the head is measured,-10 feet upstream from the center of the crest. Values of discharge (rates of flow) for heads (depths above the notch) of 1, 2, 3, 4, 5 and 6 feet, with different cross-sectional areas, are given in table 5. The discharges for heads up to 0.70 feet are not affected by the cross-sectional area at the intake and are given in table 6. The procedure employed in preparing rating tables for the triangular weirs follows:

> The cross-sectional areas of the channel in square feet at the intake corresponding to heads on the weir of 1 foot, 2 feet, 3 feet, etc., are determined. Values of discharge corresponding to the heads and cross-sectional areas are obtained from table 5. These values are plotted on log log paper together with those for heads up to 0.7 foot (table 6) for the particular weir. Discharge values for each 0.01 foot of head are obtained from the resulting graph. Thus if the particular installation should consist of a 3 to 1 weir with a total head of 4 feet and cross-sectional areas of 14 square feet for a 1-foot head, 42 square feet for a 2-foot head, 64 square feet for a 3-foot head, and 100 square feet for a 4-foot head, the values for plotting would be as follows:

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[2] The first several weirs of this type were 30 inches thick and had a somewhat differently shaped crest as shown in figure 14. Later laboratory tests showed that reducing the thickness to 16 inches and simplifying the shape of the crest did not affect the calibration of these weirs.

Head Feet	Discharge Cubic feet per second
0	0
.1	.025
.2	.132
.3	.364
.4	.757
.5	1.35
.6	2.16
.7	3.21
1.0	8.02
2.0	48.5
3.0	144
4.0	308

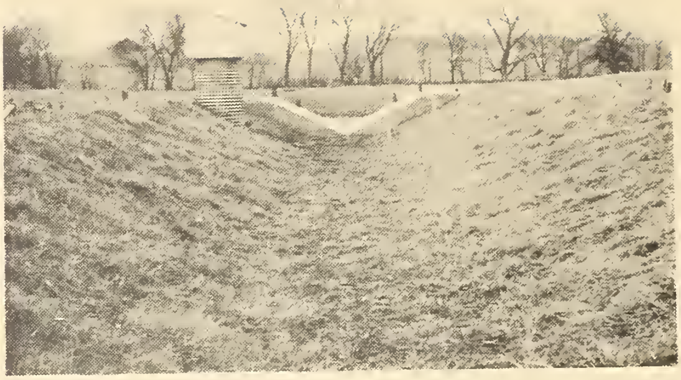
The discharge values for each 0.01 foot of head obtained from the resulting graph are tabulated to form a rating table for the weir.

Plans and details of construction of a 5 to 1 and a 3 to 1 triangular weir are shown in figures 14 and 15. A method of constructing the crest on a 5 to 1 weir is shown in plate 7,B.

MULTISLOT (GEIB) DIVISORS

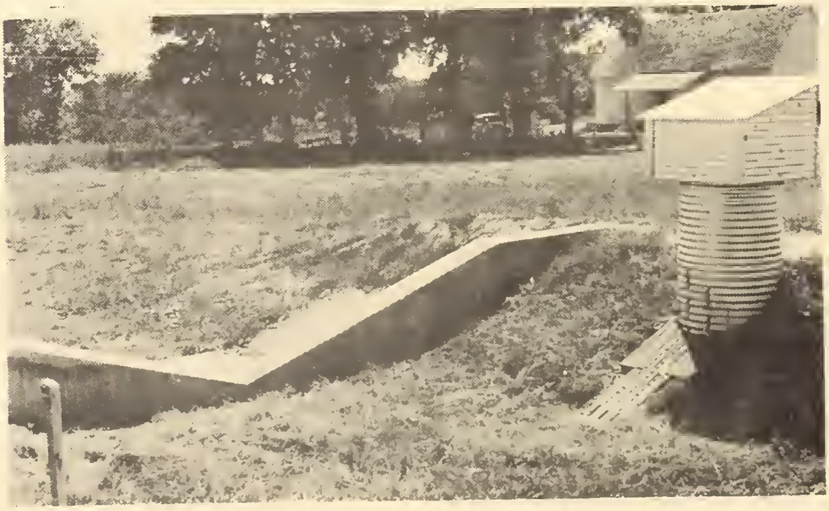
The multislot divisor (plate 8), bearing the name of its originator, was developed to measure total runoff from plots where the total amounts are too great to be collected in a tank. With this device the flow is divided into 5, 7, 9, 11, 13, or 15 aliquots, depending on the number of slots in the divisor. One of the aliquots is conveyed into a calibrated tank, while the others are allowed to waste. The total amount of runoff is obtained by multiplying the amount measured in the tank by the aliquot ratio. Aliquots smaller than 1/15th are obtained by installing two or more divisors in tandem. Thus, two 5-slot divisors would collect 1/25th of the total flow; a combination of a 5 and a 7 slot divisor would result in 1/35th aliquot, etc. The slots are either 1 inch or 1/2 inch wide. The latter are used in order to increase the depth of flow through the slots on plots where low flows of long duration are common. Drawings (figures 16 and 17) and specifications (pages 39 - 42) give details of construction and installation.

Illinois-RS-21



A, Triangular weir with 2 to 1 side slopes on a 12.5 acre terraced area near Edwardsville, Ill. Capacity 65 cubic feet per second. Note the straight alignment of this well defined channel of approach.

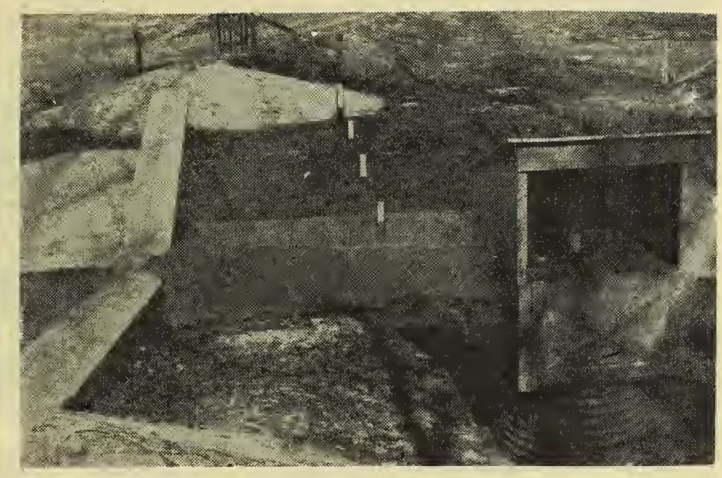
Arkansas-RS-39



B, Triangular weir with 3 to 1 side slopes on a 19.4 acre drainage near Bentonville, Ark. The cover of the intake channel in the steep bank is hinged to permit opening of stilling well door used to inspect the float of the recorder.

Plate 5

Illinois-RS-27

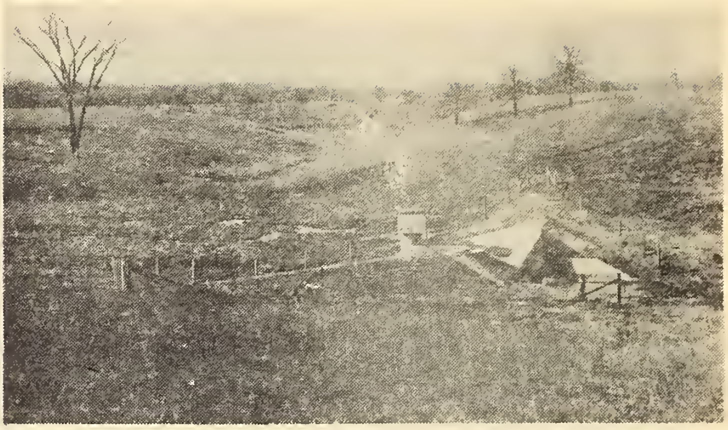


A, Triangular weir with 5 to 1 side slopes and appurtenances, (capacity 1050 cubic feet per second) on a 290-acre drainage basin near Edwardsville, Ill. The water level of the pond is read on the staff gages to check the water-level inside the stilling well. The well is placed so as not to interfere with flow over the weir. Cover of intake channel is flush with bank; holes in cover permit passage of water to slots in stilling water.

Wisconsin-RS-20

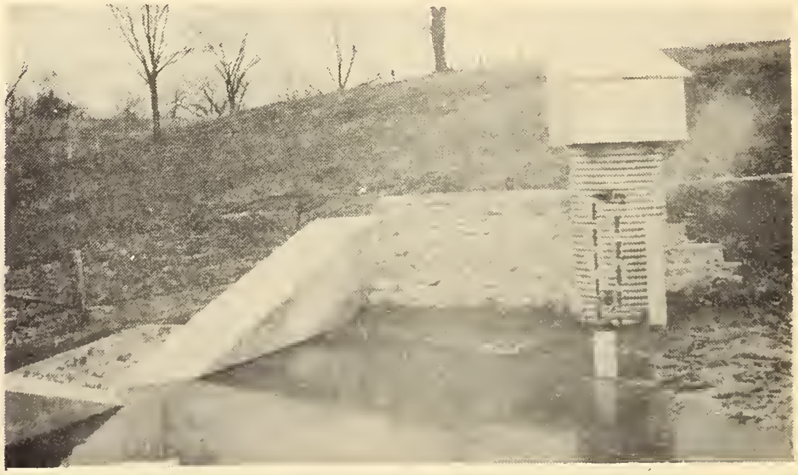
B, Triangular weir with 5 to 1 side slopes and appurtenances on a 330-acre drainage basin near Fennimore, Wisc. The intake pipe extending into the water was replaced by an intake channel similar to that shown in A. Pondage below apex of notch and artificial pondage during high flows are excessive. Rates of flow are corrected for pondage.

Illinois-RS-55



A, General view of a 3 to 1 triangular weir on a 50-acre drainage basin with a poorly defined waterway near Edwardsville, Ill. Capacity of weir 230 cubic feet per second. Dikes confine and direct flow into weir. Pondage is negligible below apex of notch but rather large for high flows. Rates are corrected for pondage.

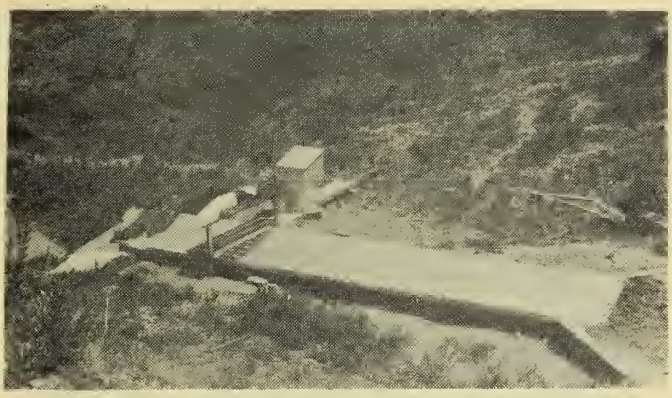
Illinois-RS-18



B, Close-up of stilling well on installation shown in A. Slots in stilling well, 1 inch wide, 6 inches long, and overlapping 1 inch, replaced two intake pipes originally used. Absence of sloping banks eliminates need of intake channel.

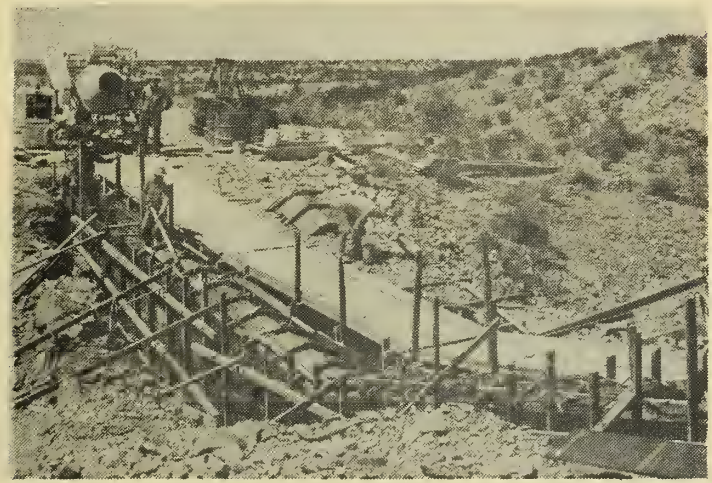
Plate 7

Texas-RS-167



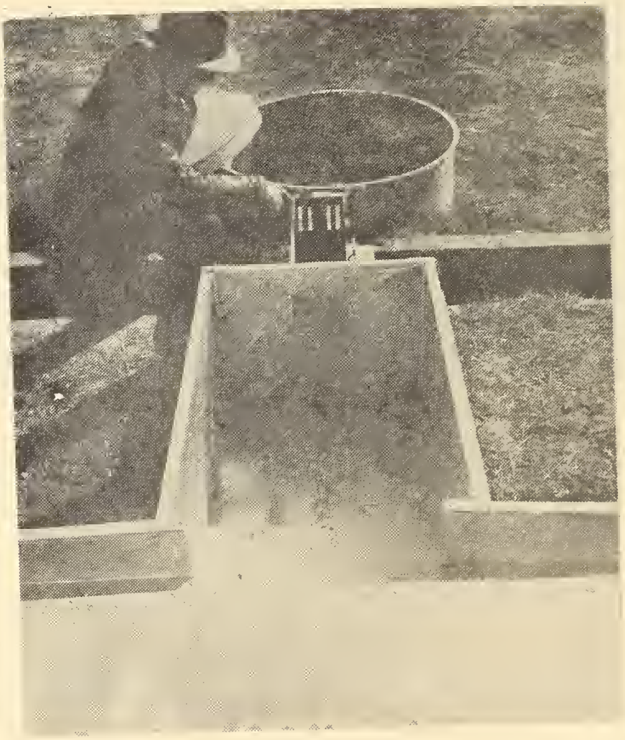
A, Experimental installation of a trapezoidal flume with 2 to 1 side slopes, 1-foot bottom width, and 3 percent grade on a 21.2-acre drainage basin producing heavy bed load. The bridge was constructed to facilitate verification of the laboratory calibration with current-meter measurements.

Arizona-RS-82



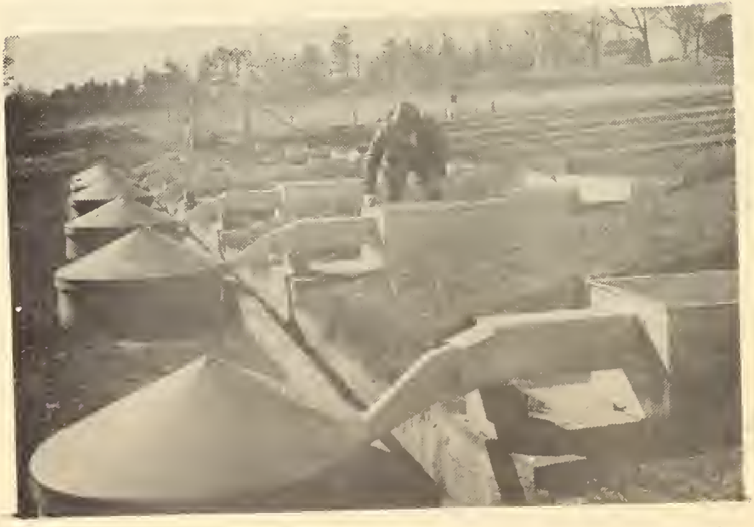
B, Construction of a 5 to 1 triangular weir on a 519-acre drainage basin near Safford, Ariz. Capacity 900 cubic feet per second. The crest of the weir is poured in sections to insure proper shape. A section of the form can be seen in the center of the picture.

North Carolina R1-6



A, Collection trough, stilling box, 5-slot (Geib multislot) divisor and calibrated tank. Aliquot, 1/5 of total runoff retained and measured.

North Carolina R1-7



B, Series of plots equipped with multislot (Geib) divisors and calibrated tanks.

SETTING WATER-LEVEL RECORDERS

HS Flumes

1. See that the water level recorder is securely fastened to its support and that the support is designed to prevent movement of the recorder relative to the measuring device. Make sure that the chart is correctly mounted on the chart drum.

2. Mount a point gage vertically over the floor near the tip of the flume. This will ordinarily be done by means of a temporary point gage support.

3. Using modeling clay ("plasticine") or some other like material, dam the outlet end of the measuring device; and, if necessary to prevent loss of water, the inlet end also. To avoid surface tension effects, the nearest point of the dam at the water surface elevation should be at least 1/2 inch away from the point of the point gage.

4. Fill the flume and float well with water until a depth of 1/2 to 1 inch of water is obtained over the control section.

5. Obtain point gage readings for the water surface and floor of flume. Subtract the crest reading from the water surface reading.

6. During the time that point gage readings are being made, the water level recorder will be making a record of water surface elevation on the chart. Subtract the difference between point gage readings from the chart reading in order to obtain the chart reading for zero head on the measuring device.

7. Check with a different amount of water in the flume.

H, HL and Parshall Flumes and Triangular Weirs

1. Form temporary watertight pool around intakes outside of stilling well.

2. Raise water level in stillwell until it is 1 or 2 inches above lowest intake.

3. Place water level recorder on floor of shelter or on shelf; install float, counterweight, and graduated float tape in position; install tape index pointer (I.P.); insert clock; place chart paper on clock; ink pen and place it in position to record.

4. Observe the record for about 5 minutes to see if the set-up is watertight. If the water level drops during this period, find the leak and repair it.

5. With Surveyor's level take backsight (B.S.) on crest of flume or notch of weir to get the elevation of the height of instrument (H.I.). All rod readings are to 0.001 foot.

6. Attach plumb bob to steel tape graduated in 0.01 foot. Set point of plumb bob at elevation of H.I. and read tape at horizontal index line (L) marked on shelter or any other convenient object over the pool. (Estimated tape reading to .001 foot.)

7. Lower plumb bob to water surface of pool and read tape at index line (L). Repeat this step for a check.

8. Read tape index pointer (I.P.) on float tape immediately after operation 7.

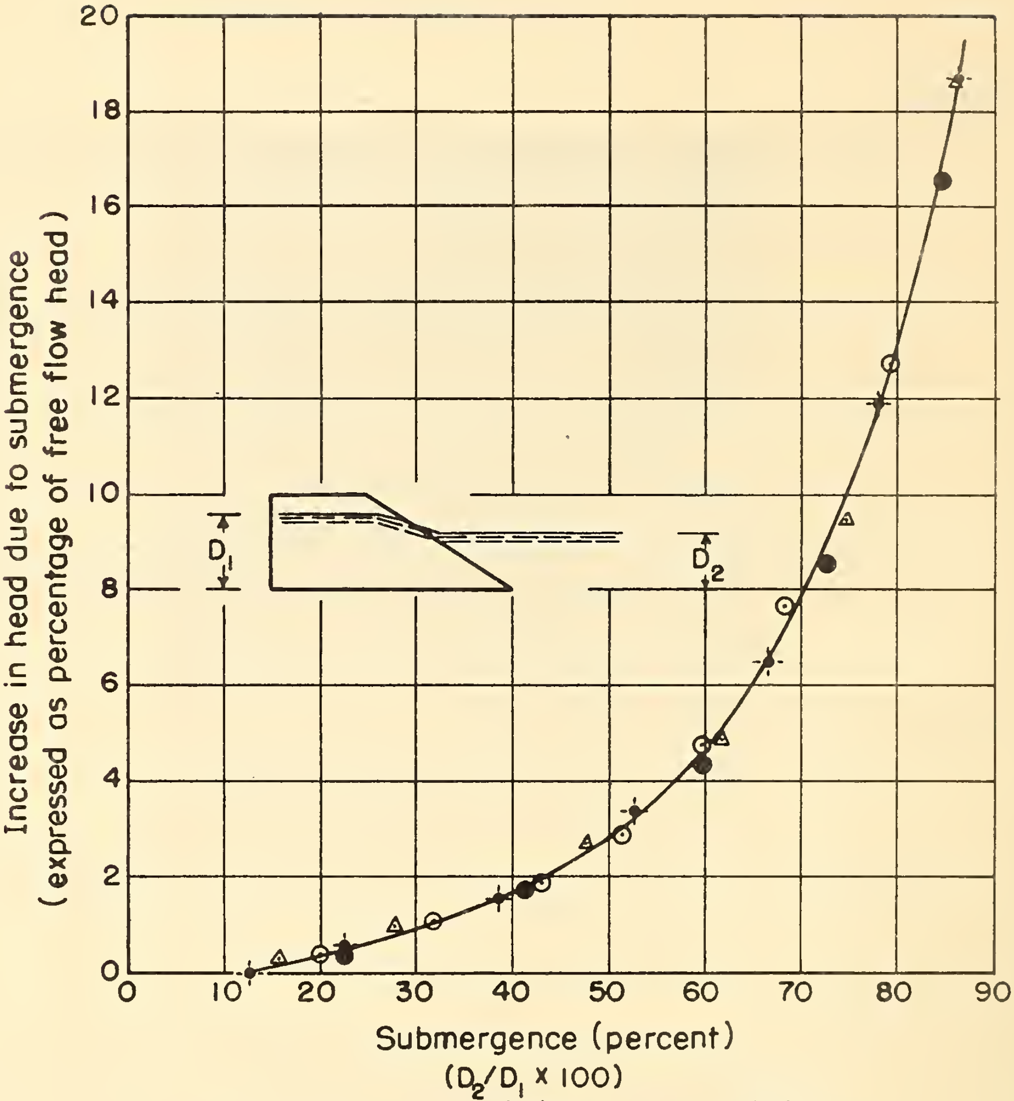
9. Subtract difference of tape readings at (L) of steps 6 and 7 from H.I. to get elevation of water surface.

10. Check H.I. by rod reading on flume crest or weir notch.

11. The difference between readings 8 and 9 is the amount the float must be lowered (if 8 is less than 9), or raised (if 8 is greater than 9) on the float tape. Minor adjustments up to 0.05 feet can be made by adjusting index pointer (I.P.).

12. Set pen on chart to read water surface elevation obtained in step 9.

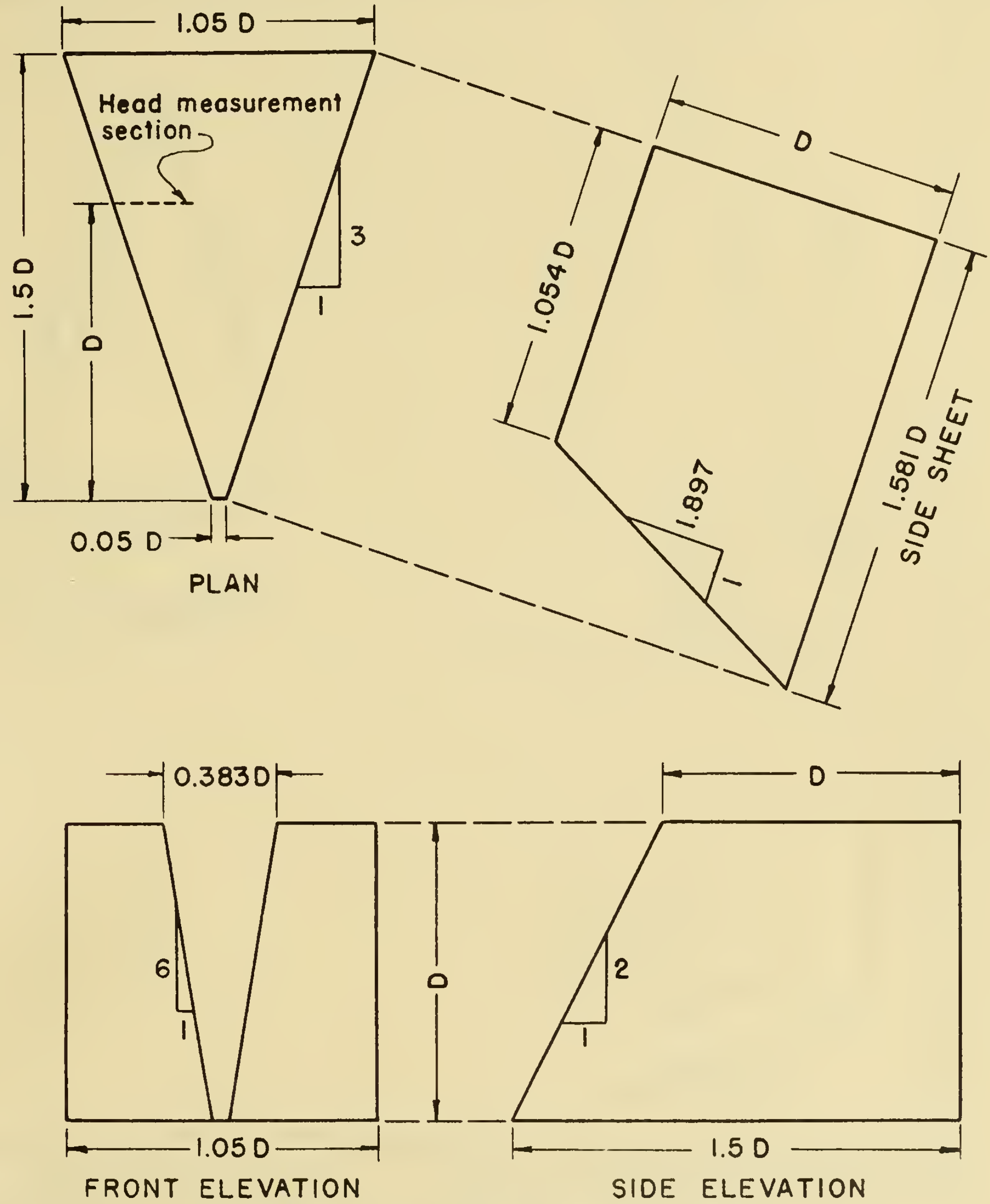
13. Check operations 5 to 12 with water at the different level.



Test run No.		Model discharge	Model free flow head
5	⊙	.103 c.f.s.	.274 feet
6	△	.252 c.f.s.	.419 feet
7	-●-	.178 c.f.s.	.352 feet
8	●	.433 c.f.s.	.527 feet

1:4 Scale ratio model of
3 foot flume

Figure 1. – Effect of submergence, H type flume.

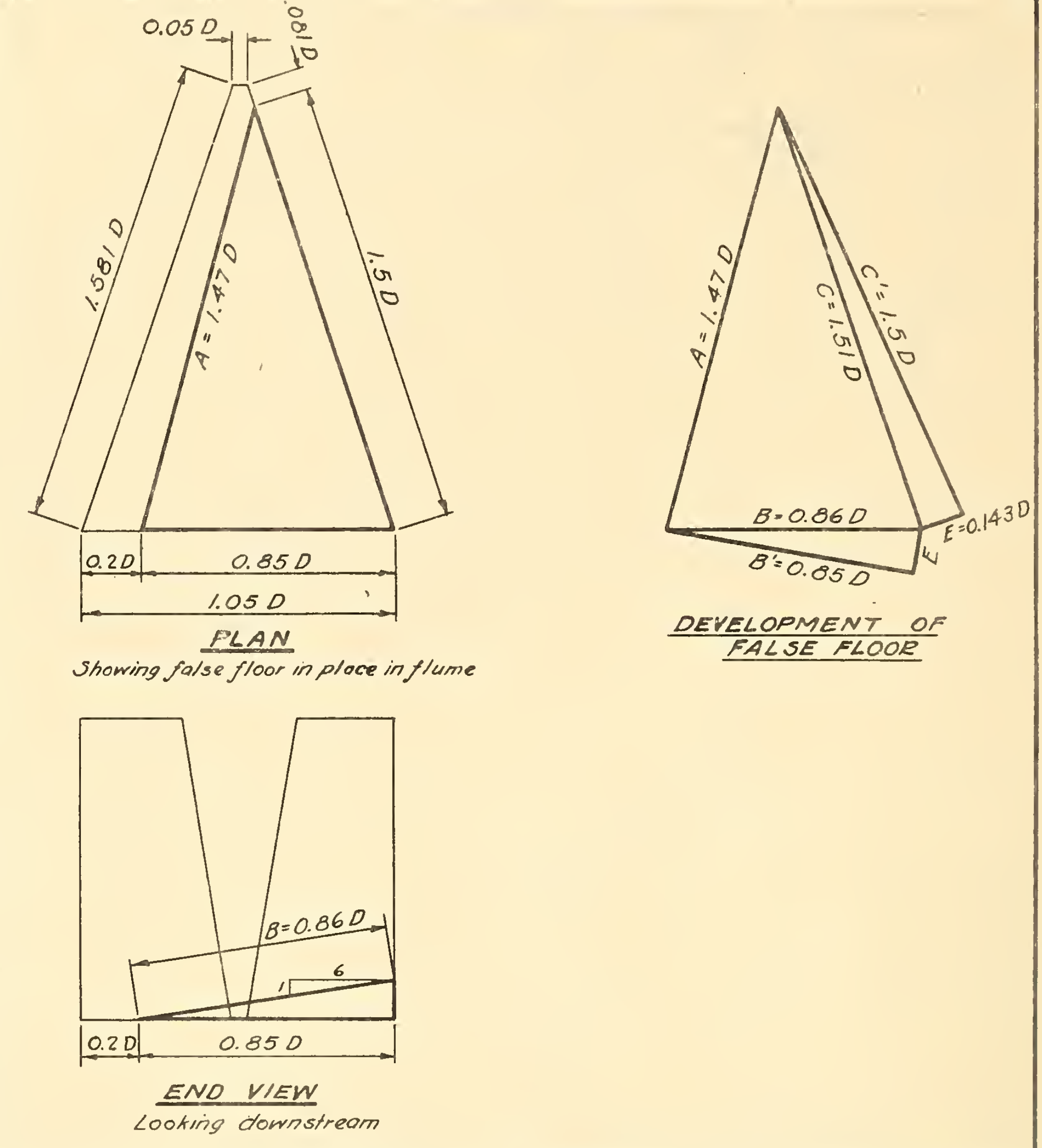


Proportions of the type HS flume

Approximate capacities

Depth - D Feet	Capacity cfs
0.4	0.085
0.6	0.23
0.8	0.47
1.0	0.82

Figure 2.- Proportions of the type HS flume.



FLUME DEPTH	SLOPING FLOOR DIMENSIONS - INCHES					
	A	B	B'	C	C'	E
0.4 FT.	7 1/16	4 1/8	4 1/16	7 1/4	7 3/16	11/16
0.5 FT.	8 3/4	5 1/8	5 1/16	9 1/16	9	7/8
0.6 FT.	10 9/16	6 3/16	6 1/8	10 7/8	10 13/16	1 1/16
0.8 FT	14 1/8	8 1/4	8 1/8	14 1/2	14 3/8	1 3/8
1.0 FT.	17 5/8	10 5/16	10 3/16	18 1/8	18	1 3/4
1.2 FT.	21 3/16	12 3/8	12 3/16	21 3/4	21 5/8	2 1/16

SLOPING FALSE FLOOR FOR USE
IN TYPE "HS" FLUMES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief

REFERENCE: Hydrologic Division
JOB NO. 4947
SUBMITTED:
APPROVED:
COMPILED: D.A.P
TRACED: AC
CHECKED: J.T.C.
DATE: 2-28-40
L-3008

Figure 3.—Dimensions of sloping false floor for HS flumes.

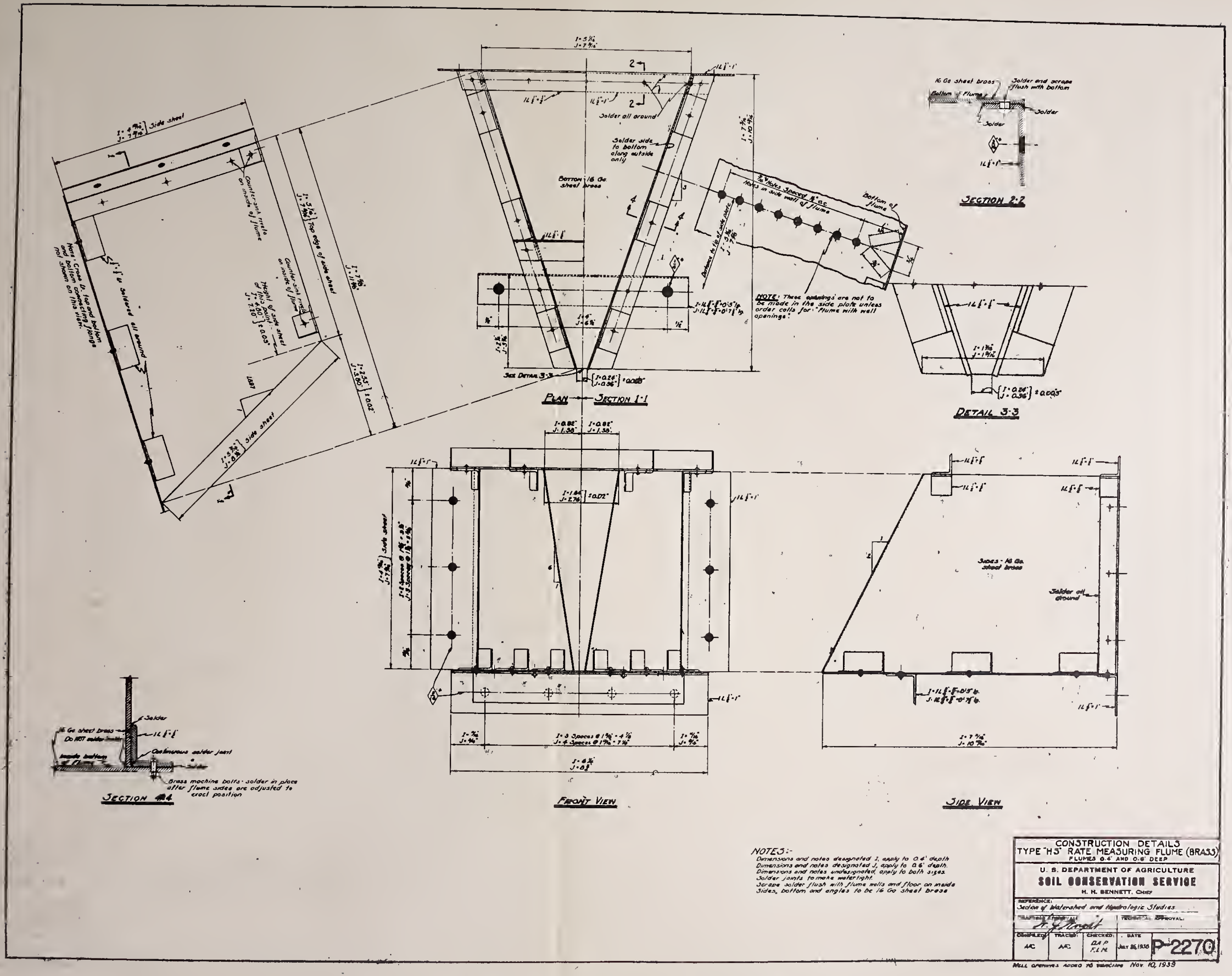

PLAN → SECTION 1-1
SECTION 2-2
DETAIL 3-3
SECTION 4-4
FRONT VIEW
SIDE VIEW
Solder all around
Solder side to bottom along outside only
Bottom 16 Ga. sheet brass
Counter-sink rivets on inside of flume
Top edge of side sheet
Height of side sheet
Side sheet
Solder all around
16 Ga sheet brass
Solder and scrape flush with bottom
Bottom of Flume
Solder
NOTE: These openings are not to be made in the side plate unless order calls for: "Flume with wall openings".
Holes in side wall of flume
Bottom of flume
See Detail 3-3
Sides - 16 Ga. sheet brass
Solder all around
16 Ga sheet brass
Do NOT solder
Continuous solder joint
Brass machine bolts - solder in place after flume sides are adjusted to exact position
NOTES:-
Dimensions and notes designated I, apply to 0.4' depth
Dimensions and notes designated J, apply to 0.6' depth.
Dimensions and notes undesignated, apply to both sizes.
Solder joints to make watertight.
Scrape solder flush with flume walls and floor on inside
Sides, bottom and angles to be 16 Ga sheet brass
CONSTRUCTION DETAILS
TYPE "HS" RATE MEASURING FLUME (BRASS)
FLUMES 0.4' AND 0.6' DEEP
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
REFERENCE:
Section of Watershed and Hydrologic Studies
TECHNICAL APPROVAL:
COMPILED: A.C.
TRACED: A.C.
CHECKED: D.A.P. F.L.M.
DATE July 26, 1938
P-2270
Well openings added to tracing Nov. 10, 1939

Figure 4.—Construction details of HS-0.4 and 0.6 ft. flumes

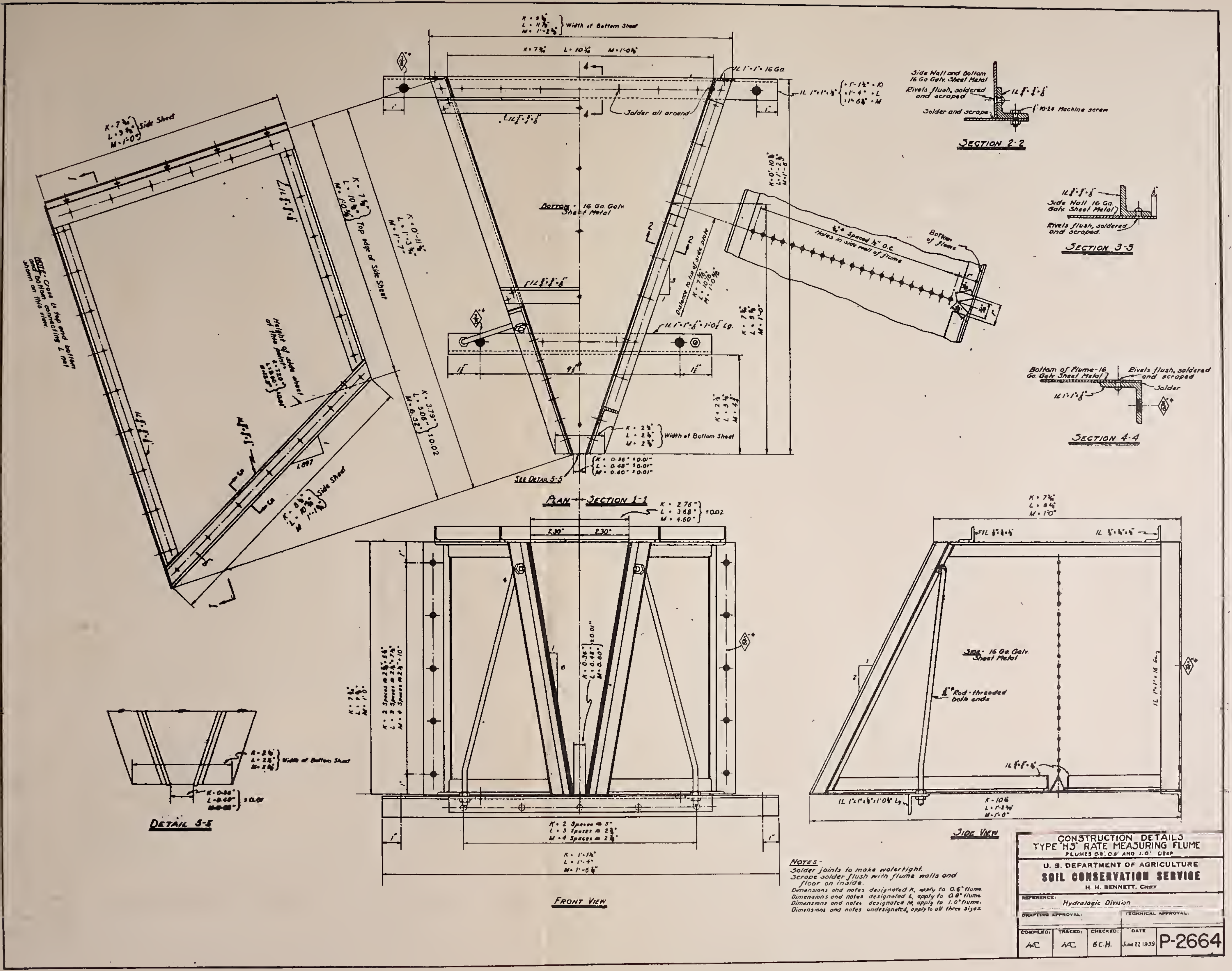

CONSTRUCTION DETAILS
TYPE "HS" RATE MEASURING FLUME
FLUMES 0.6', 0.8' AND 1.0' DEEP
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
REFERENCE: Hydrologic Division
DRAFTING APPROVAL:
TECHNICAL APPROVAL:
COMPILED: AAC
TRACED: AAC
CHECKED: GCH
DATE June 17 1939
P-2664
NOTES -
Solder joints to make watertight.
Scrape solder flush with flume walls and floor on inside.
Dimensions and notes designated K, apply to 0.6' flume.
Dimensions and notes designated L, apply to 0.8' flume.
Dimensions and notes designated M, apply to 1.0' flume.
Dimensions and notes undesignated, apply to all three sizes.
PLAN – SECTION 1-1
FRONT VIEW
SIDE VIEW
DETAIL 5-5
SECTION 2-2
SECTION 3-3
SECTION 4-4
Side Wall and Bottom 16 Ga Galv. Sheet Metal
Rivets flush, soldered and scraped
Solder and scrape
10-24 Machine screw
Side Wall 16 Ga. Galv. Sheet Metal
Bottom of Flume - 16 Ga Galv. Sheet Metal
Solder
Bottom - 16 Ga. Galv. Sheet Metal
Side - 16 Ga Galv. Sheet Metal
Solder all around
Width of Bottom Sheet
Side Sheet
Top edge of Side Sheet
Height of side sheet of three flumes
NOTE: Cross is top and bottom connecting L not shown on this view.
Holes in side wall of flume
Bottom of flume
Distance to lip of side plate
See Detail 5-5
Rod - threaded both ends
K • 0.36" ±0.01"
L • 0.48" ±0.01"
M • 0.60" ±0.01"
K • 2.76"
L • 3.68"
M • 4.60"
±0.02
2.30"
2.30"
K • 2.79"
L • 3.06"
M • 6.52"
±0.02
K • 2 Spaces @ 3"
L • 3 Spaces @ 2¾"
M • 4 Spaces @ 2¾"
K • 1'-1⅞"
L • 1'-4"
M • 1'-6⅝"
K • 10⅝
M • 1'-6"

Figure 5.— Construction details of HS-0.6, 0.8 and 1.0 ft. flumes.

Specification 119

SPECIFICATIONS

for

TYPE HS RATE MEASURING FLUME
(Brass)

I. Service Requirements

Since the HS flumes are designed to measure very small flows with a high degree of accuracy, it is necessary that the flume be constructed in strict accordance with the drawings and the following provisions of these specifications. It is especially important that the slanting opening be bounded by straight edges, have precisely the dimensions shown on the drawings, and lie in a plane having an inclination of the exact amount indicated on the drawings.

II. Drawings

The flume shall be constructed in compliance with drawing (figures 4 and 5) which is a part of these specifications.

III. Material

All materials used in the construction of this flume shall be new, of best commercial quality, and free from defects.

IV. Details of Construction

a. General: The flume shall be fabricated by riveting and soldering. All joints and seams shall be watertight and strong. The best commercial practice shall be followed in all details of construction.

b. Cutting of Plates: All plate edges shall be cut straight and sharp. The plates shall not be warped or otherwise distorted by the cutting.

c. Dimensions: All dimensions for which tolerances are not indicated on the drawings shall be within one-eight (1/8") inch of those given on the drawings.

d. Outlet Openings: The slanting outlet opening shall be formed with special care so that its dimensions are precisely as shown on the drawing. This means that the slopes, or batters, indicated by the drawing must be rigidly adhered to. The edges of the outlet opening shall be straight and smooth.

e. Fabrication: The plates shall be clamped rigidly in position and the proper dimensions and slopes obtained before the final connections are made. The side plates shall be perpendicular to the bottom of the flume. All cross sections of the flume shall be symmetrical about the longitudinal axis. All plates shall be flat and shall display no appreciable warp, dent, or other form of distortion.

f. Riveting: All riveting shall be carried out in such a way that no projections occur on the inside of the flume. All depressions in the surfaces of the plates forming the inside of the flume shall be filled with solder and dressed smooth and flush with the surfaces of the plates. All rivets shall be solid and watertight.

V. Workmanship

All operations affecting the dimensions of the outlet opening and the straightness of its edges, shall be carried out by a skilled mechanic and shall be in accordance with good machine shop practice. The completed flume shall display no deep tool marks, dents, or other blemishes.

VI. Shipment

The flumes shall be crated or otherwise protected from damage during shipment. The contractor shall be responsible for any damage arising from lack of adequate protection.

VII. Inspection

Upon delivery, the flume shall be inspected to confirm its compliance with the plans and specifications. Final acceptance of the flume will not be made until this inspection has demonstrated that all dimensions, materials, and workmanship are satisfactory.

Table 2.- Rating tables for type HS flumes. Discharge in cubic feet per second; head in feet

TYPE HS FLUME 0.4 FOOD DEEP

Head Feet	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0		.00000	.00016	.00037	.00064	.00098	.00141	.00194	.00258	.00332
.1	.00417	.00509	.00608	.00717	.00837	.00968	.0111	.0126	.0143	.0161
.2	.0179	.0200	.0221	.0244	.0268	.0293	.0320	.0348	.0378	.0409
.3	.0441	.0475	.0511	.0548	.0586	.0626	.0668	.0711	.0756	.0803

TYPE HS FLUME 0.6 FOOT DEEP

Head Feet	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0	0	.00000	.00023	.00053	.00091	.00138	.00193	.00259	.00335	.00421
.1	.00517	.00625	.00742	.00867	.0100	.0115	.0131	.0148	.0166	.0186
.2	.0207	.0229	.0252	.0277	.0303	.0330	.0359	.0389	.0421	.0454
.3	.0489	.0524	.0562	.0601	.0641	.0683	.0727	.0772	.0819	.0868
.4	.0918	.0970	.102	.108	.114	.120	.126	.132	.138	.145
.5	.152	.159	.166	.173	.181	.188	.196	.205	.213	.221

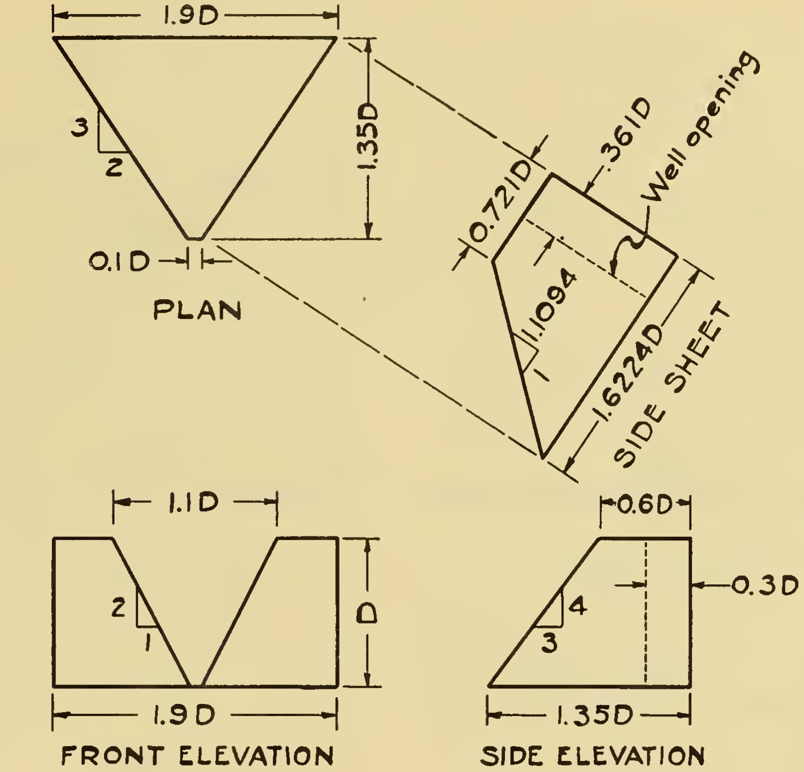
TYPE HS FLUME 0.8 FOOT DEEP

Head Feet	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0	0	.00000	.00030	.00068	.00116	.00174	.00242	.00322	.00412	.00513
.1	.00625	.00750	.00884	.0103	.0118	.0135	.0153	.0172	.0193	.0214
.2	.0237	.0262	.0287	.0314	.0343	.0373	.0404	.0437	.0471	.0506
.3	.0543	.0582	.0622	.0664	.0708	.0752	.0799	.0847	.0897	.0949
.4	.100	.106	.111	.117	.123	.129	.136	.142	.149	.156
.5	.163	.170	.178	.186	.193	.202	.210	.218	.227	.236
.6	.245	.254	.264	.273	.283	.293	.303	.314	.325	.336
.7	.347	.358	.370	.381	.393	.406	.418	.431	.444	.457

TYPE HS FLUME 1.0 FOOT DEEP

Head Feet	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0	0	.00000	.00037	.00083	.00141	.00209	.00290	.00384	.00489	.00606
.1	.00736	.00882	.0103	.0120	.0137	.0157	.0177	.0198	.0221	.0245
.2	.0270	.0297	.0325	.0355	.0386	.0418	.0452	.0488	.0525	.0563
.3	.0603	.0645	.0688	.0733	.0779	.0827	.0877	.0929	.0981	.104
.4	.109	.115	.121	.127	.134	.140	.147	.154	.161	.168
.5	.176	.183	.191	.199	.208	.216	.225	.233	.243	.252
.6	.261	.271	.281	.291	.301	.312	.322	.333	.344	.355
.7	.367	.379	.391	.403	.416	.428	.441	.454	.468	.481
.8	.495	.509	.524	.538	.553	.568	.583	.599	.614	.630
.9	.646	.663	.680	.697	.714	.731	.749	.767	.785	.803

Rating derived from tests made by the Soil Conservation Service at Washington, D. C. and Minneapolis, Minnesota. Table prepared April 1941.



PROPORTIONS OF THE TYPE H FLUME

APPROXIMATE CAPACITIES

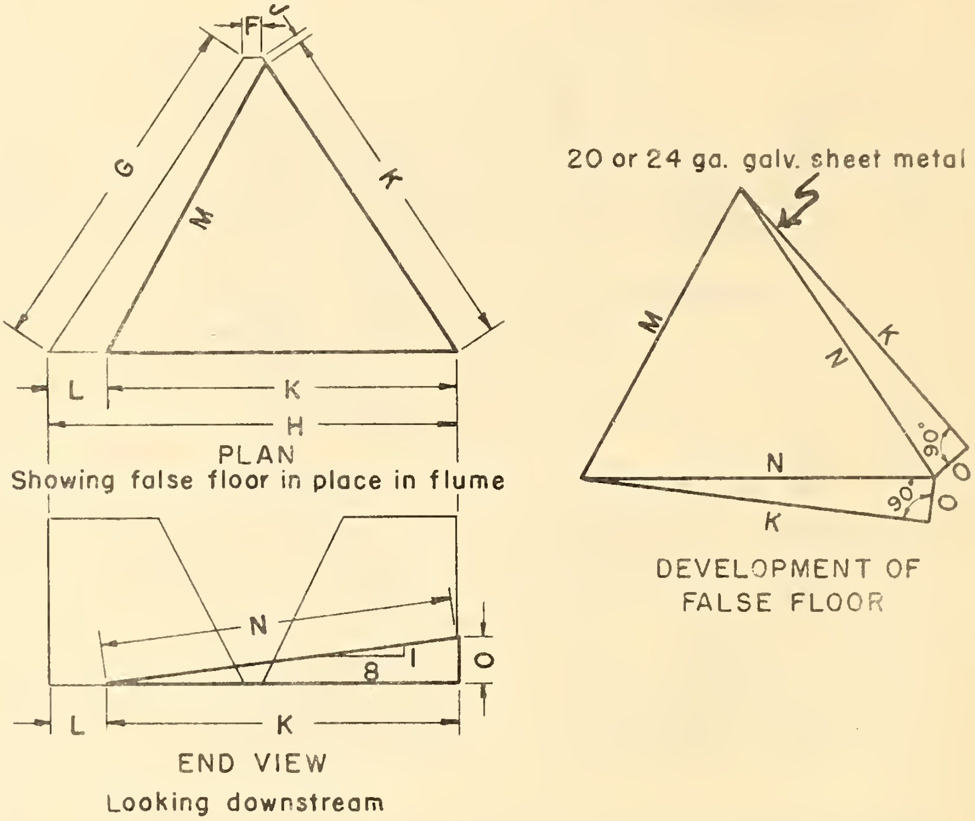
DEPTH-D Feet	CAPACITY CFS
0.5	0.3+
0.75	1-
1.0	2
1.5	5+
2.0	11
2.5	19+
3.0	30+

Note: For flumes less than 1 foot deep, the length of flume is made greater than 1.35 D so that the float well may be attached.

H.L.G.-MAY 1937

39 L-2494

Figure 6.—Proportions of the type H flume.



PLAN
Showing false floor in place in flume

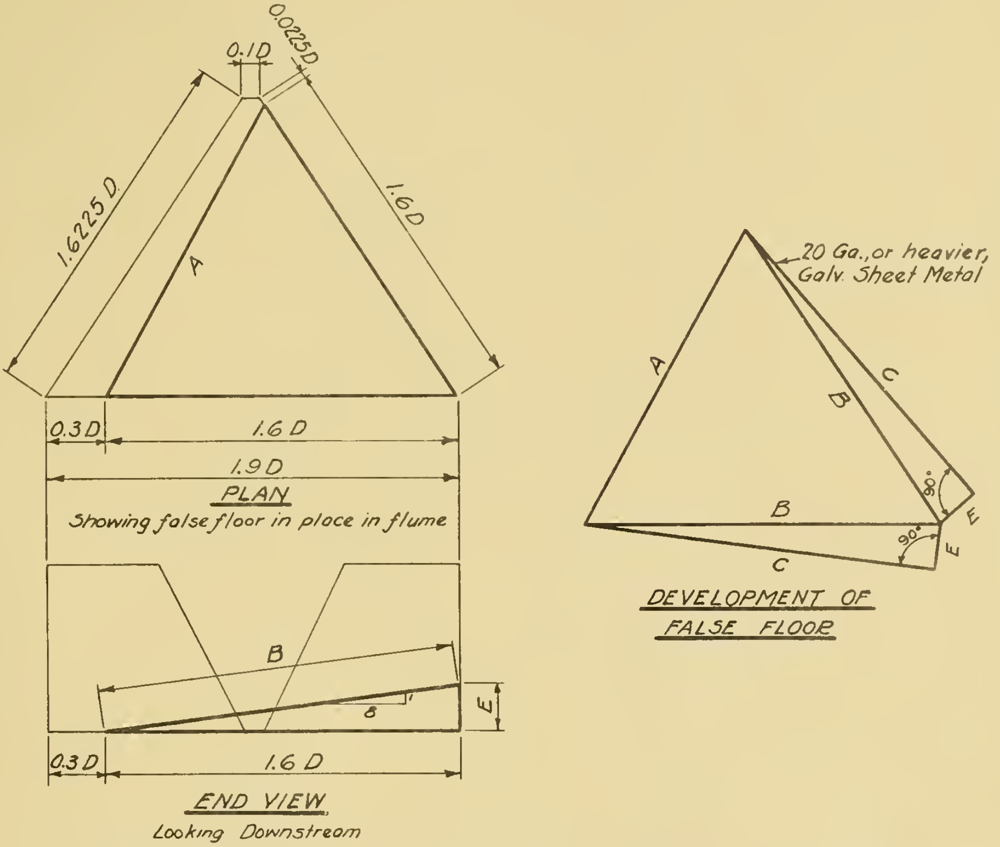
END VIEW
Looking downstream

DEVELOPMENT OF
FALSE FLOOR

FLUME DEPTH	F	G	H	J	K	L	M	N	O
6	0.6	16 1/2	19	3/16	16 5/16	2 11/16	15 3/8	16 7/16	2
9	0.9	19 3/16	22 3/16	1/4	18 15/16	3 1/4	17 7/8	19 1/16	2 3/8
12	1.2	21 7/8	25 7/16	5/16	21 9/16	3 7/8	20 3/8	21 3/4	2 11/16

All dimensions in inches

Figure 7.-Dimensions of sloping false floor H-0.5, 0.75 and 1.0 ft. flumes


0.1D
0.0225D
1.6225 D
1.6D
A
0.3D
1.6 D
1.9 D
PLAN
Showing false floor in place in flume
20 Ga., or heavier, Galv. Sheet Metal
A
B
C
90°
E
B
C
90°
E
DEVELOPMENT OF FALSE FLOOR
B
8
1
E
0.3 D
1.6 D
END VIEW
Looking Downstream

FLUME DEPTH	A = 1.51 D		B = 1.6125 D		C = 1.6 D		E = 0.2 D	
D-FEET	FEET	INCHES	FEET	INCHES	FEET	INCHES	FEET	INCHES
1.5	2.265	27 3/16	2.419	29	2.4	28 13/16	0.3	3 5/8
2.0	3.02	36 1/4	3.225	38 11/16	3.2	38 3/8	0.4	4 13/16
2.5	3.775	45 5/16	4.031	48 3/8	4.0	48	0.5	6
3.0	4.53	54 3/8	4.838	58 1/16	4.8	57 5/8	0.6	7 3/16

SLOPING FALSE FLOOR FOR USE IN LARGE TYPE "H" FLUMES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief

REFERENCE:
Sed. of Soil & Water Conservation Experiment Stations

SUBMITTED:
APPROVED:

COMPILED:	TRACED:	CHECKED:	DATE	
L.L.D.	WC	~~F.L.M.~~ D.A.P.	MAY 6, 1938	L-2179

PRINTED ON "WAR"
K & E CO

Figure 8.—Dimensions of sloping false floor for H-1.5, 2.0, 2.5 and 3.0 ft. flumes.

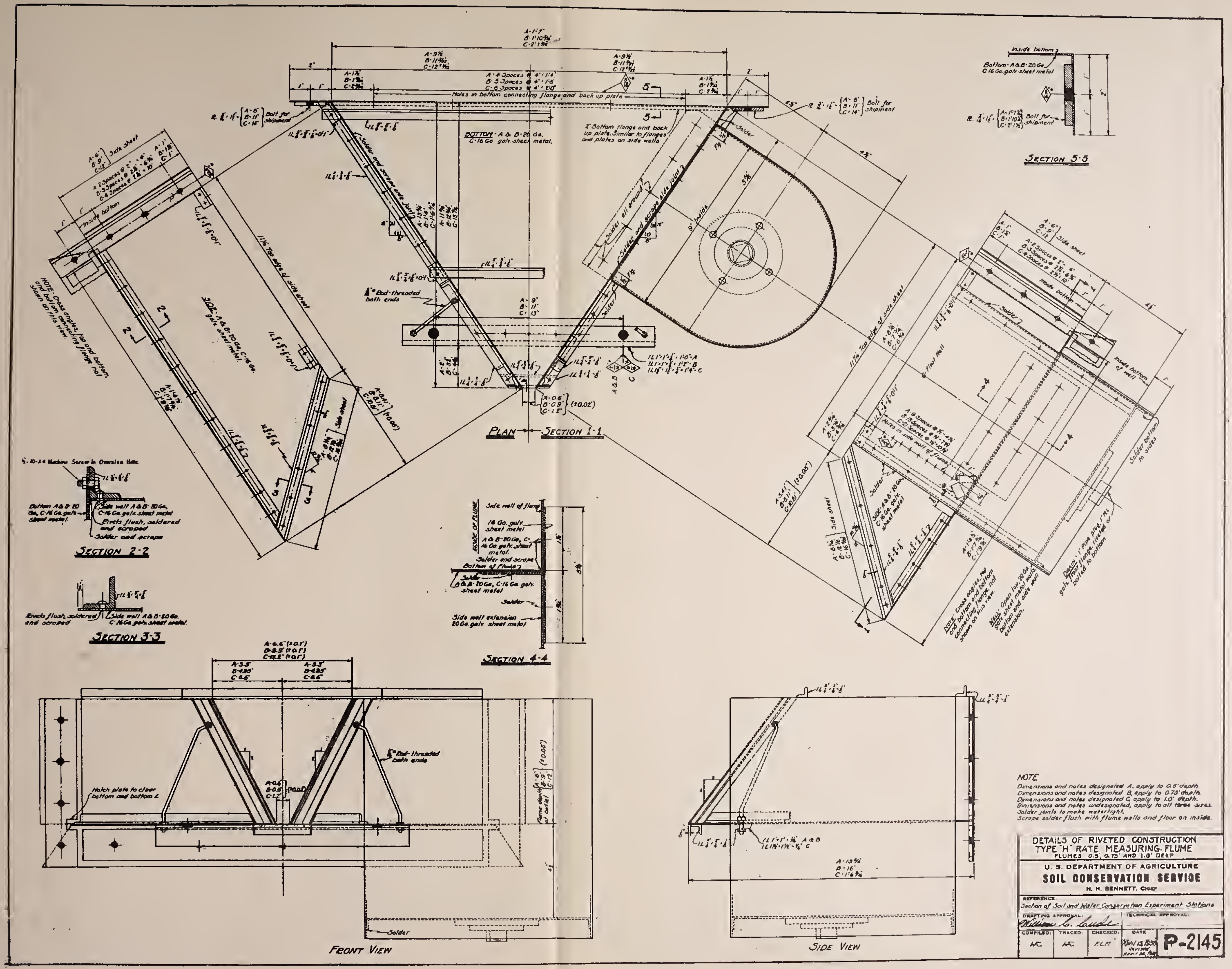

PLAN
SECTION 1-1
SECTION 2-2
SECTION 3-3
SECTION 4-4
SECTION 5-5
FRONT VIEW
SIDE VIEW
NOTE: Cross angles top and bottom and bottom connecting flange not shown on this view.
NOTE
Dimensions and notes designated A. apply to 0.5' depth.
Dimensions and notes designated B. apply to 0.75' depth.
Dimensions and notes designated C. apply to 1.0' depth.
Dimensions and notes undesignated, apply to all three sizes.
Solder joints to make watertight.
Scrape solder flush with flume walls and floor on inside.
DETAILS OF RIVETED CONSTRUCTION
TYPE "H" RATE MEASURING FLUME
FLUMES 0.5', 0.75' AND 1.0' DEEP
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, CHIEF
REFERENCE:
Section of Soil and Water Conservation Experiment Stations
DRAFTING APPROVAL:
TECHNICAL APPROVAL:
COMPILED: HC
TRACED: HC
CHECKED: F.L.M.
DATE
P-2145

Figure 9.-Construction details of H-0.5, 0.75 and 1.0 ft. flumes

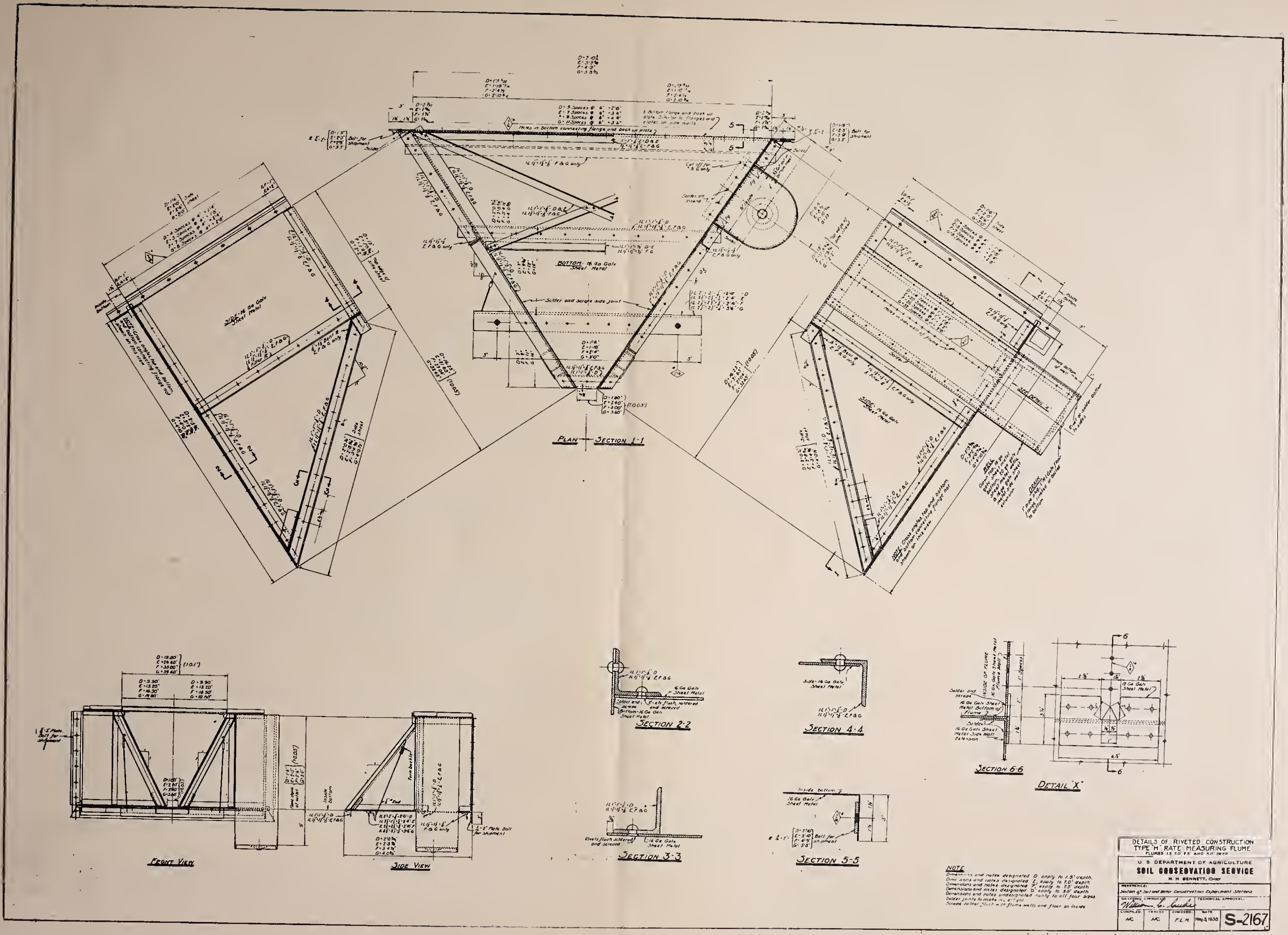

PLAN — SECTION 1-1
BOTTOM: 16 Ga Galv Sheet Metal
SIDE: 16 Ga Galv Sheet Metal
Solder and scrape side joint
Holes in bottom connecting flange and back up plate
FRONT VIEW
SIDE VIEW
SECTION 2-2
SECTION 3-3
SECTION 4-4
SECTION 5-5
SECTION 6-6
DETAIL "X"
NOTE
Dimensions and notes designated D apply to 1.5' depth.
Dimensions and notes designated E apply to 2.0' depth.
Dimensions and notes designated F apply to 2.5' depth.
Dimensions and notes designated G apply to 3.0' depth.
Dimensions and notes undesignated apply to all four sizes.
Solder joints to make watertight
Scrape solder flush with flume walls and floor on inside
DETAILS OF RIVETED CONSTRUCTION
TYPE "H" RATE MEASURING FLUME
FLUMES 1.5', 2.0', 2.5' AND 3.0' DEEP
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief
REFERENCE:
Section of Soil and Water Conservation Experiment Stations
DRAFTING APPROVAL: William C. Cauker
TECHNICAL APPROVAL:
COMPILED: AC
TRACED: AC
CHECKED: F.L.M.
DATE: May 3 1938
S-2167

Figure 10.- Construction details of H-1.5, 2.0, 2.5 and 3.0 ft. flumes

Specifications 111-A

SPECIFICATIONS -- TYPE H RATE MEASURING FLUME
(Riveted Construction)

I. Service Requirements

To measure flows with the required degree of accuracy, it is necessary that the flume be constructed in strict accordance with the drawing and the following provisions of these specifications. It is especially important that the slanting opening be bounded by straight edges and have precisely the dimensions shown on the drawing.

II. Drawings

The flume shall be constructed in compliance with the proper drawing (figures 9, 10). (The depth of the flume desired is indicated on the appended invitation to bid). The necessary drawings are attached to and made a part of these specifications.

III. Material

a. General: All materials used in the construction of this flume shall be new, of best commercial quality, and free from defects.

b. Sheet Metal: The sheet metal shall be of galvanized open hearth iron or copper bearing steel.

c. Structural Angles: All structural angles shall be made of high grade structural steel, and shall be galvanized. They shall be straight, and the surfaces of the legs shall be planes.

d. Rivets: All rivets shall be of non-rusting ferrous alloy or of iron coated with non-rusting material.

IV. Details of Construction

a. General: The flume shall be fabricated by riveting and soldering. All joints and seams shall be watertight and strong. The best commercial practice shall be followed in all details of construction.

b. Cutting of Plates: All plate edges shall be cut straight and sharp. The plates shall not be warped or otherwise distorted by the cutting.

c. Joints: The vertical sides of the flume shall be made from one sheet. The bottom plate shall not contain more than one joint and no portion of this joint shall lie within twelve (12") inches of the outlet opening. Any necessary joint in the bottom plate shall be transverse to the longitudinal axis of the flume and shall be made so that the joint is substantially flush.

d. Dimensions: All dimensions for which tolerances are not indicated on the drawings shall be within one-fourth (1/4") inch of those given on the drawings.

e. Outlet Opening: The slanting outlet opening shall be formed with special care so that its dimensions are precisely as shown on the drawing. This means that the slopes indicated by the drawing must be rigidly adhered to. The edges of the outlet opening shall be straight and smooth.

f. Fabrication: The plates shall be clamped rigidly in position and the proper dimensions and slopes obtained before the final connections are made. The side plates shall be perpendicular to the bottom of the flume. All cross sections of the flume shall be symmetrical about the longitudinal axis. All plates shall be flat and shall display no appreciable warp, dent, or other form of distortion.

g. Riveting: All riveting shall be carried out in such a way that no projections occur on the inside of the flume. All depressions in the surfaces of the plates forming the inside of the flume shall be filled with solder and dressed smooth and flush with the surfaces of the plates. All rivets shall be solid and watertight.

V. Workmanship

All operations affecting the dimensions of the outlet opening and the straightness of its edges, shall be carried out by a skilled mechanic and shall be in accordance with good machine shop practice. The best sheet metal shop practices shall be followed in all other operations. The completed flume shall display no deep tool marks, dents, or other blemishes.

VI. Shipment

The flumes shall be crated or otherwise protected from damage during shipment. The contractor shall be responsible for any damage arising from lack of adequate protection.

VII. Inspection

Upon delivery, the flume shall be inspected to confirm its compliance with the plans and specifications. Final acceptance of the flume will not be made until this inspection has demonstrated that all dimensions, materials, and workmanship are satisfactory.

Table 3.- Rating tables for type H flumes. Discharge in cubic feet per second; head in feet.

Type H flume 0.5 foot deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	.0004	.0009	.0016	.0024	.0035	.0047	.0063	.0080
.1	.0101	.0122	.0146	.0173	.0202	.0233	.0267	.0304	.0343	.0385
.2	.0431	.0479	.0530	.0585	.0643	.0704	.0767	.0834	.0905	.0979
.3	.1057	.1139	.1224	.1314	.1407	.1505	.1607	.1713	.1823	.1938
.4	.205	.217	.230	.244	.257	.271	.285	.300	.315	.331

October 1938

Type H flume 0.75 foot deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	.0006	.0013	.0022	.0032	.0046	.0061	.0080	.0101
.1	.0126	.0151	.0179	.0210	.0242	.0278	.0317	.0358	.0403	.0451
.2	.0501	.0555	.0612	.0672	.0735	.0802	.0872	.0946	.1023	.1104
.3	.119	.128	.137	.146	.156	.167	.177	.188	.199	.211
.4	.224	.237	.250	.263	.277	.291	.306	.321	.337	.353
.5	.370	.388	.406	.424	.443	.462	.482	.502	.523	.544
.6	.566	.588	.611	.635	.659	.683	.708	.734	.760	.786
.7	.813	.841	.869	.898	.927	.957				

January 1939

Type H flume 1.0 foot deep

Head	00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0.	0	T.	.0007	.0017	.0027	.0040	.0056	.0075	.0097	.0122
.1	.0150	.0179	.0211	.0246	.0284	.0324	.0367	.0413	.0462	.0515
.2	.0571	.0630	.0692	.0758	.0827	.0900	.0976	.1055	.1138	.1226
.3	.132	.141	.151	.161	.172	.183	.194	.206	.218	.231
.4	.244	.257	.271	.285	.300	.315	.331	.347	.364	.381
.5	.398	.416	.434	.453	.472	.492	.512	.533	.554	.576
.6	.598	.621	.644	.668	.692	.717	.743	.769	.796	.823
.7	.851	.880	.909	.939	.969	1.000	1.031	1.063	1.096	1.129
.8	1.16	1.20	1.23	1.27	1.30	1.34	1.38	1.41	1.45	1.49
.9	1.53	1.57	1.61	1.66	1.70	1.74	1.78	1.83	1.87	1.92

October 1938

Type H flume 1.5 feet deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0.	T.	.0011	.0023	.0039	.0057	.0078	.0103	.0131	.0164
.1	.0200	.0237	.0276	.0319	.0365	.0414	.0467	.0523	.0582	.0645
.2	.0711	.0780	.0854	.0931	.1011	.1095	.1183	.1275	.1371	.1470
.3	.157	.168	.179	.191	.203	.215	.228	.241	.255	.269
.4	.283	.298	.314	.330	.346	.363	.380	.398	.416	.435
.5	.454	.473	.493	.514	.535	.557	.579	.601	.624	.648
.6	.672	.697	.722	.747	.773	.800	.827	.855	.883	.912
.7	.942	.972	1.002	1.033	1.065	1.097	1.130	1.163	1.197	1.231
.8	1.27	1.30	1.34	1.38	1.41	1.45	1.49	1.53	1.57	1.61
.9	1.65	1.69	1.73	1.78	1.82	1.86	1.91	1.95	2.00	2.05
1.0	2.09	2.14	2.19	2.24	2.30	2.35	2.40	2.45	2.50	2.56
1.1	2.61	2.67	2.73	2.78	2.84	2.90	2.96	3.02	3.08	3.14
1.2	3.20	3.27	3.33	3.39	3.46	3.52	3.59	3.66	3.73	3.80
1.3	3.87	3.94	4.01	4.08	4.15	4.22	4.30	4.37	4.45	4.52
1.4	4.60	4.68	4.76	4.84	4.92	5.00	5.08	5.16	5.24	5.33

October 1938

Type H flume 2.0 feet deep

Head	00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	.0014	.0031	.0050	.0073	.0100	.0130	.0166	.0205
.1	.0248	.0293	.0341	.0392	.0447	.0505	.0567	.0632	.0701	.0774
.2	.0850	.0930	.1015	.1103	.1195	.1290	.1390	.1494	.1602	.1714
.3	.183	.195	.207	.220	.234	.248	.262	.276	.291	.307
.4	.323	.339	.356	.374	.392	.410	.429	.448	.468	.488
.5	.509	.530	.552	.574	.597	.620	.644	.668	.693	.719
.6	.745	.771	.798	.826	.854	.882	.911	.941	.971	1.002
.7	1.03	1.07	1.10	1.13	1.16	1.20	1.23	1.27	1.30	1.34
.8	1.38	1.42	1.46	1.49	1.53	1.57	1.62	1.66	1.70	1.74
.9	1.78	1.83	1.87	1.92	1.96	2.01	2.06	2.10	2.15	2.20
1.0	2.25	2.30	2.35	2.40	2.45	2.51	2.56	2.62	2.67	2.73
1.1	2.78	2.84	2.90	2.96	3.02	3.08	3.14	3.20	3.26	3.32
1.2	3.38	3.45	3.51	3.58	3.65	3.71	3.78	3.85	3.92	3.99
1.3	4.06	4.13	4.20	4.28	4.35	4.43	4.50	4.58	4.66	4.74
1.4	4.82	4.90	4.98	5.06	5.14	5.23	5.31	5.40	5.48	5.57
1.5	5.65	5.74	5.83	5.92	6.01	6.11	6.20	6.29	6.38	6.48
1.6	6.58	6.67	6.77	6.87	6.97	7.07	7.17	7.27	7.37	7.47
1.7	7.58	7.68	7.79	7.90	8.00	8.11	8.22	8.33	8.44	8.56
1.8	8.67	8.78	8.90	9.01	9.13	9.24	9.36	9.48	9.60	9.72
1.9	9.85	9.97	10.09	10.21	10.34	10.47	10.60	10.72	10.85	10.98

October 1938

Rating derived from tests made by the Soil Conservation Service at the Hydraulic Laboratory of the National Bureau of Standards

Table 3.- Rating tables for type H flumes. Discharge in cubic feet per second; head in feet. Continued-

Type H flume 2.5 feet deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0.	0.	T.	.0018	.0038	.0061	.0089	.0121	.0158	.0200	.0247
.1	.0298	.0350	.0406	.0465	.0528	.0595	.0666	.0741	.0820	.0903
.2	.0990	.1081	.1176	.1275	.1379	.1486	.1597	.1713	.1834	.1960
.3	.209	.222	.236	.250	.265	.280	.296	.312	.328	.345
.4	.363	.381	.399	.418	.437	.457	.478	.499	.520	.542
.5	.564	.587	.611	.635	.659	.684	.710	.736	.763	.790
.6	.818	.846	.875	.904	.934	.965	.996	1.027	1.059	1.092
.7	1.13	1.16	1.19	1.23	1.27	1.30	1.34	1.38	1.41	1.45
.8	1.49	1.53	1.57	1.61	1.65	1.70	1.74	1.78	1.83	1.87
.9	1.92	1.96	2.01	2.06	2.11	2.16	2.21	2.26	2.31	2.36
1.0	2.41	2.46	2.51	2.57	2.62	2.68	2.74	2.79	2.85	2.91
1.1	2.97	3.03	3.09	3.15	3.21	3.27	3.33	3.40	3.46	3.53
1.2	3.59	3.66	3.73	3.80	3.86	3.93	4.00	4.07	4.15	4.22
1.3	4.29	4.37	4.44	4.52	4.59	4.67	4.75	4.82	4.90	4.98
1.4	5.06	5.15	5.23	5.31	5.39	5.48	5.56	5.65	5.74	5.82
1.5	5.91	6.00	6.09	6.18	6.27	6.37	6.46	6.55	6.65	6.75
1.6	6.84	6.94	7.04	7.14	7.24	7.34	7.45	7.55	7.66	7.76
1.7	7.86	7.97	8.08	8.19	8.30	8.41	8.53	8.64	8.75	8.87
1.8	8.98	9.10	9.22	9.34	9.45	9.57	9.70	9.82	9.94	10.06
1.9	10.2	10.3	10.4	10.6	10.7	10.8	11.0	11.1	11.2	11.4
2.0	11.5	11.6	11.8	11.9	12.0	12.2	12.3	12.5	12.6	12.7
2.1	12.9	13.0	13.2	13.3	13.5	13.6	13.8	13.9	14.1	14.2
2.2	14.4	14.5	14.7	14.8	15.0	15.1	15.3	15.5	15.6	15.8
2.3	16.0	16.1	16.3	16.4	16.6	16.8	17.0	17.1	17.3	17.5
2.4	17.6	17.8	18.0	18.2	18.3	18.5	18.7	18.9	19.1	19.2

October 1938

Type H flume 3.0 feet deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	.0021	.0045	.0073	.0105	.0143	.0186	.0234	.0288
.1	.0347	.0407	.0471	.0538	.0610	.0686	.0766	.0851	.0939	.1032
.2	.113	.123	.134	.145	.156	.168	.180	.193	.207	.220
.3	.234	.249	.264	.280	.296	.312	.329	.347	.365	.383
.4	.402	.421	.441	.462	.483	.504	.526	.549	.572	.596
.5	.620	.644	.669	.695	.721	.748	.775	.803	.832	.861
.6	.890	.920	.951	.982	1.014	1.047	1.080	1.113	1.147	1.182
.7	1.22	1.25	1.29	1.33	1.36	1.40	1.44	1.48	1.52	1.56
.8	1.60	1.65	1.69	1.73	1.78	1.82	1.86	1.91	1.96	2.00
.9	2.05	2.10	2.15	2.20	2.25	2.30	2.35	2.41	2.46	2.51
1.0	2.57	2.62	2.68	2.73	2.79	2.85	2.91	2.97	3.03	3.09
1.1	3.15	3.21	3.27	3.34	3.40	3.46	3.53	3.60	3.66	3.73
1.2	3.80	3.87	3.94	4.01	4.08	4.15	4.23	4.30	4.37	4.45
1.3	4.53	4.60	4.68	4.76	4.84	4.92	5.00	5.08	5.16	5.24
1.4	5.33	5.41	5.50	5.58	5.67	5.76	5.84	5.93	6.02	6.11
1.5	6.20	6.30	6.39	6.48	6.58	6.67	6.77	6.87	6.96	7.06
1.6	7.16	7.26	7.36	7.47	7.57	7.67	7.78	7.88	7.99	8.10
1.7	8.20	8.31	8.42	8.53	8.64	8.75	8.87	8.98	9.10	9.21
1.8	9.33	9.45	9.56	9.68	9.80	9.92	10.05	10.17	10.29	10.41
1.9	10.5	10.7	10.8	10.9	11.0	11.2	11.3	11.4	11.6	11.7
2.0	11.9	12.0	12.1	12.3	12.4	12.6	12.7	12.8	13.0	13.1
2.1	13.3	13.4	13.6	13.7	13.9	14.0	14.2	14.3	14.5	14.6
2.2	14.8	14.9	15.1	15.3	15.4	15.6	15.7	15.9	16.1	16.2
2.3	16.4	16.6	16.7	16.9	17.1	17.2	17.4	17.6	17.8	17.9
2.4	18.1	18.3	18.5	18.7	18.8	19.0	19.2	19.4	19.6	19.8
2.5	19.9	20.1	20.3	20.5	20.7	20.9	21.1	21.3	21.5	21.7
2.6	21.9	22.1	22.3	22.5	22.7	22.9	23.1	23.3	23.5	23.7
2.7	23.9	24.1	24.3	24.5	24.7	24.9	25.2	25.4	25.6	25.8
2.8	26.0	26.2	26.5	26.7	26.9	27.1	27.4	27.6	27.8	28.0
2.9	28.3	28.5	28.7	28.9	29.2	29.4	29.7	29.9	30.1	30.4

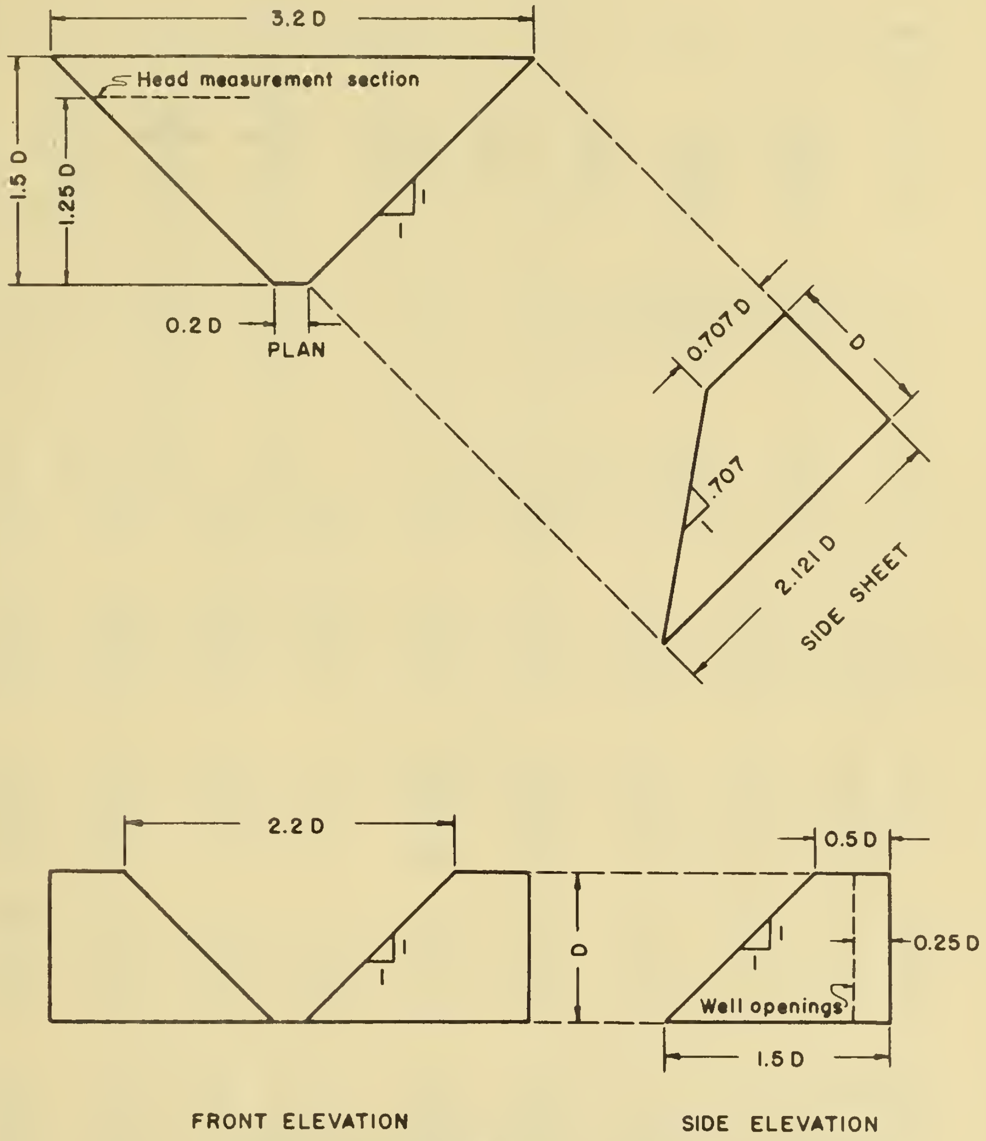
October 1938

Type H flume 4.5 feet deep

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T	.0031	.0066	.0106	.0154	.0208	.0269	.0337	.0413
.1	.0496	.0578	.0666	.0758	.0855	.0959	.1067	.1180	.1298	.1420
.2	.155	.168	.182	.196	.211	.226	.242	.259	.276	.293
.3	.311	.330	.349	.368	.388	.409	.430	.452	.474	.497
.4	.520	.544	.569	.594	.620	.646	.673	.700	.728	.756
.5	.785	.815	.845	.876	.907	.939	.972	1.005	1.039	1.073
.6	1.11	1.14	1.18	1.22	1.25	1.29	1.33	1.38	1.41	1.45
.7	1.49	1.53	1.58	1.62	1.66	1.71	1.75	1.80	1.84	1.89
.8	1.94	1.99	2.04	2.09	2.14	2.19	2.24	2.29	2.35	2.40
.9	2.45	2.51	2.56	2.62	2.68	2.74	2.79	2.85	2.91	2.98
1.0	3.04	3.10	3.16	3.22	3.29	3.35	3.42	3.49	3.55	3.62
1.1	3.69	3.76	3.83	3.90	3.97	4.94	4.12	4.19	4.27	4.34
1.2	4.42	4.50	4.58	4.65	4.73	4.81	4.89	4.98	5.06	5.14
1.3	5.22	5.31	5.39	5.48	5.57	5.66	5.74	5.83	5.92	6.02
1.4	6.11	6.20	6.29	6.39	6.48	6.58	6.68	6.77	6.87	6.97
1.5	7.07	7.17	7.27	7.37	7.48	7.59	7.69	7.80	7.90	8.01
1.6	8.12	8.23	8.34	8.45	8.56	8.68	8.79	8.90	9.02	9.14
1.7	9.25	9.37	9.49	9.61	9.73	9.85	9.98	10.10	10.22	10.35
1.8	10.5	10.6	10.7	10.8	11.0	11.1	11.2	11.4	11.5	11.6
1.9	11.8	11.9	12.0	12.2	12.3	12.5	12.6	12.8	12.9	13.0
2.0	13.2	13.3	13.5	13.6	13.7	13.9	14.1	14.2	14.4	14.5
2.1	14.7	14.8	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1
2.2	16.3	16.4	16.6	16.8	16.9	17.1	17.3	17.4	17.6	17.8
2.3	18.0	18.1	18.3	18.5	18.7	18.8	19.0	19.2	19.4	19.6
2.4	19.7	19.9	20.1	20.3	20.5	20.7	20.9	21.0	21.2	21.4
2.5	21.6	21.8	22.0	22.2	22.4	22.6	22.8	23.0	23.2	23.4
2.6	23.6	23.8	24.0	24.2	24.4	24.6	24.9	25.1	25.3	25.5
2.7	25.7	25.9	26.1	26.4	26.6	26.8	27.0	27.2	27.4	27.7
2.8	27.9	28.1	28.4	28.6	28.8	29.0	29.3	29.5	29.7	30.0
2.9	30.2	30.4	30.7	30.9	31.2	31.4	31.7	31.9	32.2	32.4
3.0	32.7	32.9	33.2	33.4	33.7	33.9	34.2	34.4	34.7	35.0
3.1	35.2	35.5	35.8	36.0	36.3	36.6	36.8	37.1	37.4	37.7
3.2	37.9	38.2	38.5	38.8	39.0	39.3	39.6	39.9	40.2	40.5
3.3	40.8	41.2	41.3	41.6	41.9	42.2	42.5	42.8	43.1	43.4
3.4	43.7	44.0	44.3	44.6	44.9	45.2	45.5	45.8	46.1	46.4
3.5	46.8	47.1	47.4	47.7	48.0	48.3	48.6	49.0	49.3	49.6
2.6	49.9	50.3	50.6	50.9	51.2	51.6	51.9	52.2	52.6	52.9
3.7	53.2	53.6	53.9	54.3	54.6	54.9	55.3	55.6	56.0	56.3
3.8	56.7	57.0	57.4	57.7	58.1	58.4	58.8	59.2	59.5	59.9
3.9	60.2	60.6	61.0	61.3	61.7	62.1	62.4	62.8	63.2	63.6
4.0	63.9	64.3	64.7	65.1	65.4	65.8	66.2	66.6	67.0	67.4
4.1	67.8	68.2	68.5	68.9	69.3	69.7	70.1	70.5	70.9	71.3
4.2	71.7	72.1	72.5	72.9	73.3	73.8	74.2	74.6	75.0	75.4
4.3	75.8	76.2	76.6	77.1	77.5	77.9	78.3	78.8	79.2	79.6
4.4	80.0	80.5	80.9	81.3	81.8	82.2	82.6	83.1	83.5	84.0

December 1939

Rating derived from tests made by the Soil Conservation Service at the Hydraulic Laboratory of the National Bureau of Standards



Proportions of the type HL flume

Approximate capacities

Depth - D Feet	Capacity cfs
2.0	20
2.5	35
3.0	55
3.5	80
4.0	110

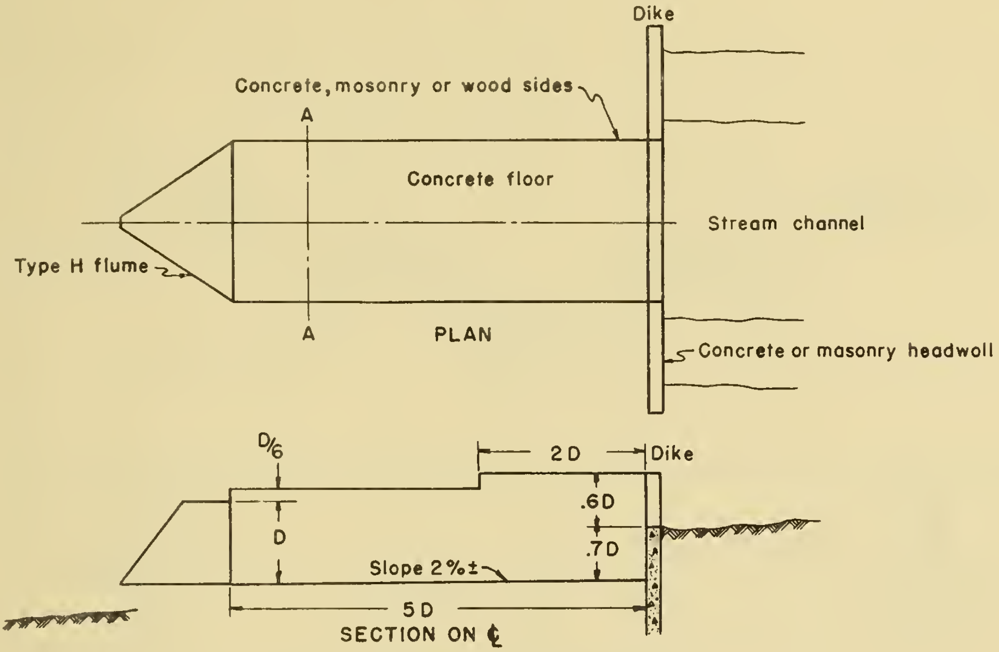
For this range in maximum flows it is better to use H-type flumes

Fig. 11 - Dimensions of HL-type flumes

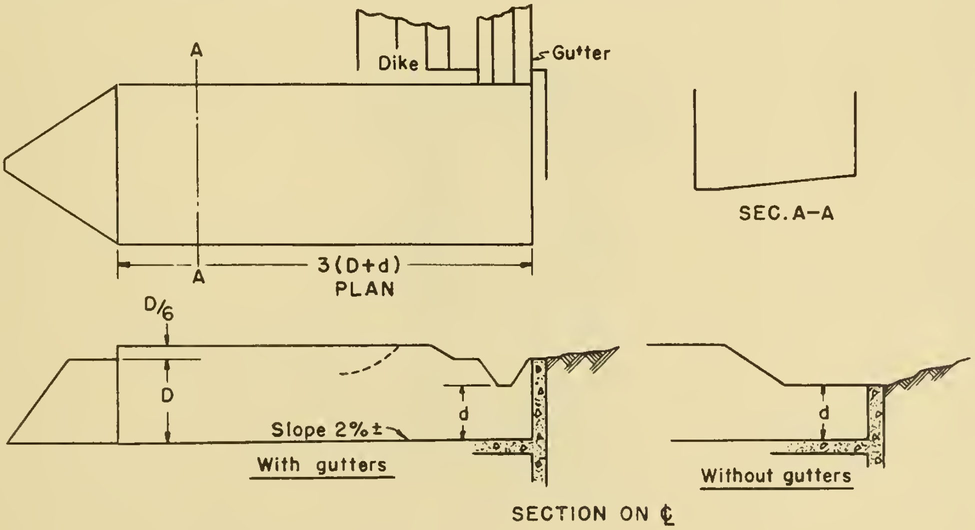
Table 4.- Rating table for 4-ft. HL Flume. Discharge in cubic feet per second; head in feet

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	.000	T.	.005	.012	.020	.029	.039	.050	.062	.075
.1	.089	.103	.119	.135	.152	.170	.190	.211	.232	.255
.2	.278	.302	.327	.352	.378	.405	.434	.465	.497	.530
.3	.565	.600	.635	.670	.705	.740	.780	.820	.860	.900
.4	.940	.982	1.03	1.08	1.12	1.17	1.22	1.27	1.32	1.37
.5	1.42	1.48	1.53	1.59	1.64	1.70	1.76	1.82	1.88	1.94
.6	2.01	2.07	2.14	2.21	2.28	2.35	2.42	2.49	2.56	2.64
.7	2.71	2.79	2.87	2.95	3.03	3.11	3.19	3.28	3.36	3.44
.8	3.53	3.61	3.70	3.79	3.88	3.98	4.08	4.18	4.28	4.38
.9	4.48	4.58	4.68	4.79	4.90	5.01	5.12	5.23	5.34	5.45
1.0	5.56	5.68	5.80	5.92	6.04	6.16	6.28	6.40	6.52	6.64
1.1	6.76	6.89	7.02	7.15	7.28	7.41	7.54	7.67	7.80	7.93
1.2	8.06	8.20	8.35	8.50	8.65	8.80	8.95	9.10	9.25	9.40
1.3	9.55	9.70	9.90	10.1	10.2	10.4	10.5	10.7	10.8	11.0
1.4	11.2	11.4	11.6	11.7	11.9	12.1	12.3	12.4	12.6	12.8
1.5	13.0	13.2	13.3	13.5	13.7	13.9	14.1	14.3	14.5	14.7
1.6	14.9	15.1	15.3	15.5	15.7	15.9	16.2	16.4	16.6	16.8
1.7	17.0	17.2	17.4	17.6	17.8	18.1	18.3	18.5	18.7	19.0
1.8	19.2	19.4	19.7	19.9	20.2	20.4	20.6	20.9	21.2	21.4
1.9	21.7	21.9	22.1	22.4	22.7	23.0	23.2	23.4	23.7	24.0
2.0	24.3	24.5	24.8	25.0	25.3	25.6	25.8	26.1	26.4	26.7
2.1	27.0	27.3	27.6	27.9	28.2	28.5	28.8	29.1	29.4	29.7
2.2	30.0	30.3	30.6	30.9	31.2	31.5	31.9	32.2	32.5	32.8
2.3	33.1	33.5	33.8	34.1	34.5	34.8	35.1	35.4	35.8	36.1
2.4	36.5	36.8	37.1	37.4	37.8	38.2	38.5	38.8	39.1	39.5
2.5	39.9	40.3	40.6	41.0	41.4	41.7	42.1	42.4	42.8	43.2
2.6	43.6	43.9	44.3	44.7	45.1	45.5	45.8	46.2	46.6	47.1
2.7	47.5	47.9	48.2	48.6	49.0	49.4	49.8	50.2	50.7	51.1
2.8	51.6	52.0	52.4	52.8	53.3	53.7	54.1	54.5	54.9	55.4
2.9	55.9	56.3	56.7	57.2	57.6	58.1	58.6	59.1	59.5	59.9
3.0	60.3	60.8	61.3	61.8	62.3	62.8	63.2	63.7	64.1	64.6
3.1	65.1	65.6	66.1	66.6	67.1	67.5	68.0	68.5	69.0	69.5
3.2	70.0	70.5	71.0	71.5	72.0	72.5	73.0	73.5	74.0	74.5
3.3	75.0	75.5	76.0	76.5	77.0	77.6	78.2	78.7	79.3	79.9
3.4	80.5	80.9	81.5	82.0	82.6	83.1	83.6	84.2	84.8	85.3
3.5	85.9	86.5	87.1	87.7	88.3	88.9	89.5	90.1	90.7	91.3
3.6	91.9	92.5	93.1	93.7	94.3	94.9	95.5	96.1	96.7	97.4
3.7	98.0	98.6	99.2	99.8	100.	101.	102.	102.	103.0	104.
3.8	104.	105.	106.	106.	107.	107.	108.	109.	109.	110.
3.9	111.	111.	112.	113.	113.	114.	115.	115.	116.	116.
4.0	117.									

Rating derived from tests made at the National Bureau of Standards.
Table prepared July 1940.



STRAIGHT HEADWALL INSTALLATION
(for use when flume is to be installed in a well defined natural chonnel)



DROP BOX INSTALLATION
(for use when the runoff must be concentrated by gutters or dikes)

Figure 12— Type HS, H and HL flume installation

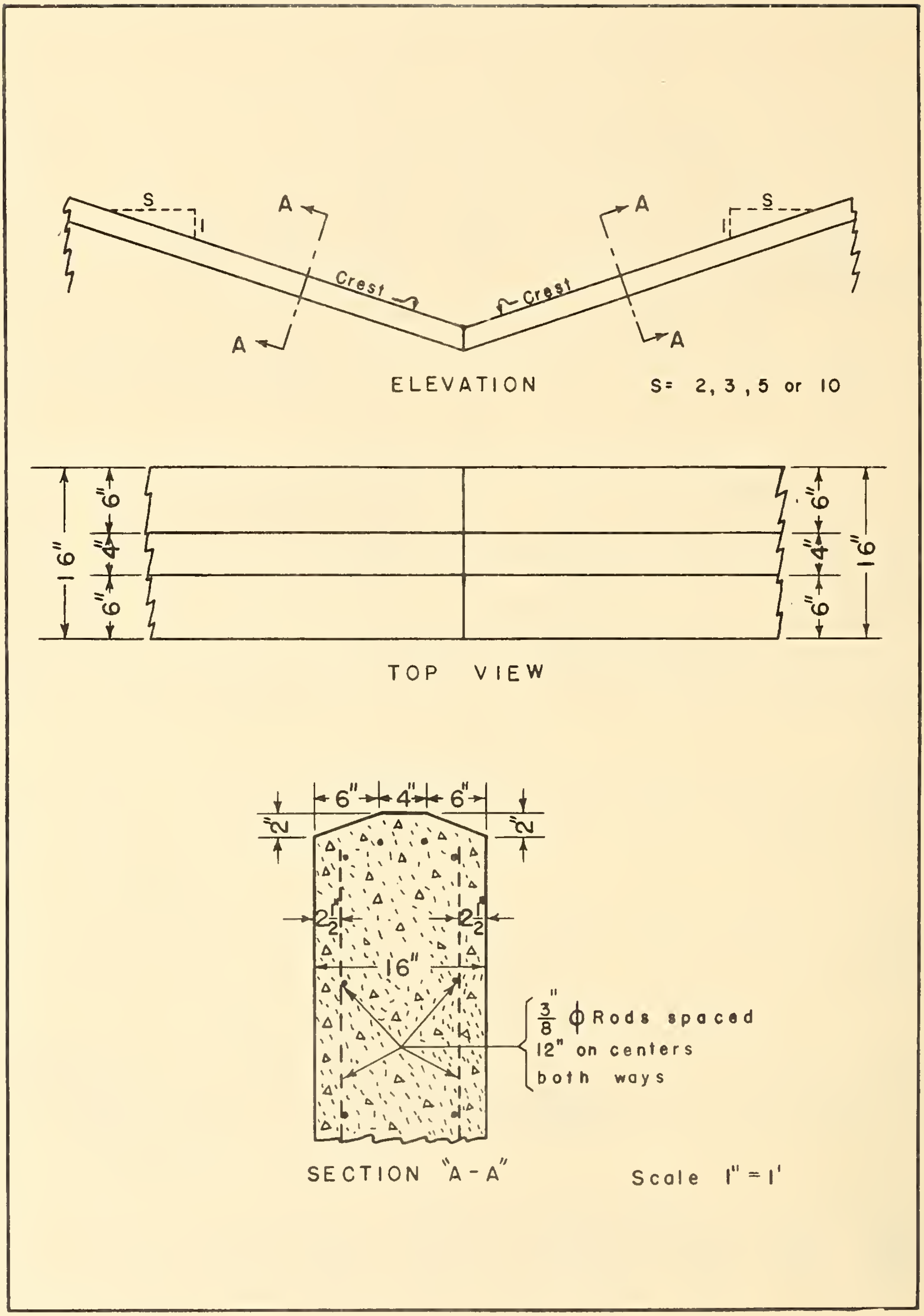


Figure 13.—Shapes of 16 inch crest of triangular weirs.

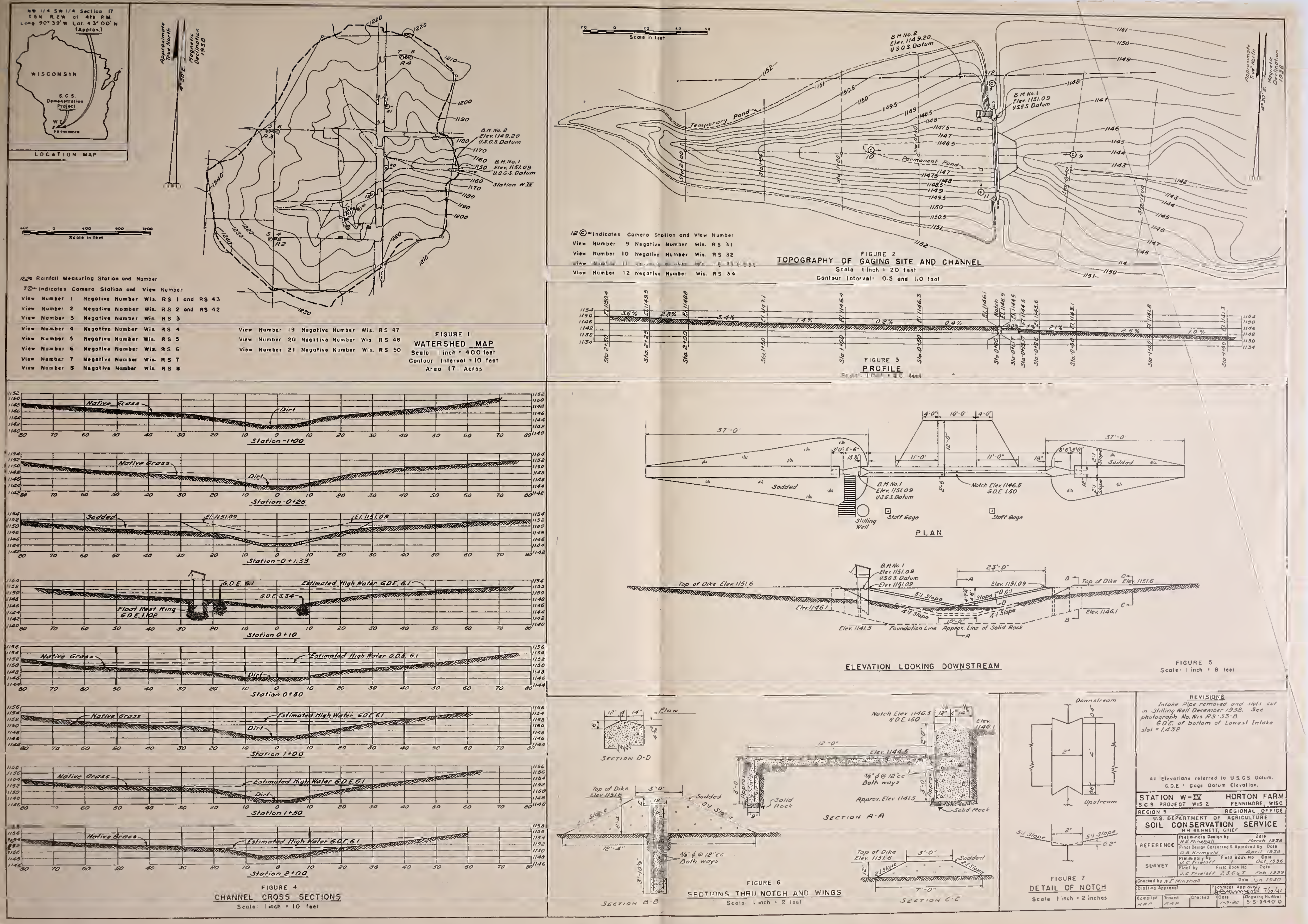

NW 1/4 SW 1/4 Section 17
T 6N R 2W of 4th P.M.
Long 90°39'W Lat. 43°00'N
(Approx.)
WISCONSIN
S.C.S. Demonstration Project
W-I
Fennimore
LOCATION MAP
Approximate True North
Magnetic Declination 1938
4°30' E.
Scale in feet
R2 Rainfall Measuring Station and Number
7© Indicates Camera Station and View Number
View Number 1 Negative Number Wis. RS 1 and RS 43
View Number 2 Negative Number Wis. RS 2 and RS 42
View Number 3 Negative Number Wis. RS 3
View Number 4 Negative Number Wis. RS 4
View Number 5 Negative Number Wis. RS 5
View Number 6 Negative Number Wis. RS 6
View Number 7 Negative Number Wis. RS 7
View Number 8 Negative Number Wis. RS 8
View Number 19 Negative Number Wis. RS 47
View Number 20 Negative Number Wis. RS 48
View Number 21 Negative Number Wis. RS 50
B.M. No. 2 Elev. 1149.20 U.S.G.S. Datum
B.M. No. 1 Elev. 1151.09 U.S.G.S. Datum
Station W-IV
FIGURE 1
WATERSHED MAP
Scale 1 inch = 400 feet
Contour Interval = 10 feet
Area 171 Acres
Scale in feet
Temporary Pond
Permanent Pond
12© Indicates Camera Station and View Number
View Number 9 Negative Number Wis. RS 31
View Number 10 Negative Number Wis. RS 32
View Number 11 Negative Number Wis. RS 33
View Number 12 Negative Number Wis. RS 34
FIGURE 2
TOPOGRAPHY OF GAGING SITE AND CHANNEL
Scale 1 inch = 20 feet
Contour Interval: 0.5 and 1.0 feet
FIGURE 3
PROFILE
Native Grass
Dirt
Sodded
El. 1151.09
G.D.E. 6.1
Estimated High Water G.D.E. 6.1
G.D.E. 3.34
Float Rest Ring G.D.E. 1.02
Station -1+00
Station -0+26
Station -0+1.33
Station 0+10
Station 0+50
Station 1+00
Station 1+50
Station 2+00
FIGURE 4
CHANNEL CROSS SECTIONS
Scale: 1 inch = 10 feet
Sodded
B.M. No. 1 Elev. 1151.09 U.S.G.S. Datum
Notch Elev. 1146.5 G.D.E. 1.50
Stilling Well
Staff Gage
PLAN
Top of Dike Elev. 1151.6
5:1 Slope
4:1 Slope
Elev. 1146.1
Elev. 1141.5
Foundation Line
Approx. Line of Solid Rock
ELEVATION LOOKING DOWNSTREAM
FIGURE 5
Scale: 1 inch = 8 feet
Flow
SECTION D-D
Top of Dike Elev. 1151.6
3/8" ϕ @ 12" cc Both ways
SECTION B-B
Notch Elev. 1146.5 G.D.E. 1.50
Elev. 1144.5
Approx. Elev. 1141.5
Solid Rock
SECTION A-A
SECTION C-C
FIGURE 6
SECTIONS THRU NOTCH AND WINGS
Scale: 1 inch = 2 feet
Downstream
Upstream
5:1 Slope
FIGURE 7
DETAIL OF NOTCH
Scale 1 inch = 2 inches
REVISIONS
Intake Pipe removed and slots cut in Stilling Well December 1938. See photograph No. Wis RS-33-B.
G.D.E. of bottom of Lowest Intake slot = 1.432
All Elevations referred to U.S.G.S. Datum.
G.D.E. = Gage Datum Elevation.
STATION W-IV
S.C.S. PROJECT WIS 2
HORTON FARM
FENNIMORE, WISC.
REGION 5
REGIONAL OFFICE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H.H. BENNETT, CHIEF
REFERENCE
Preliminary Design by N.E. Minshall Date March 1938
Final Design Corrected & Approved by D.B. Krimgold Date April 1938
SURVEY
Preliminary by J.C. Trieloff Field Book No. 1 Date Oct. 1936
Final by J.C. Trieloff Field Book No. 2, 3, 6 & 7 Date Feb. 1939
Checked by N.E. Minshall Date Jan 1940
Drafting Approval
Technical Approval D.B. Krimgold 7/10/40
Compiled RAP
Traced RAP
Checked
Date 1-2-40
Drawing Number 5-S-5440-0

Figure 14.-Plan and construction details of a 5:1 triangular weir.

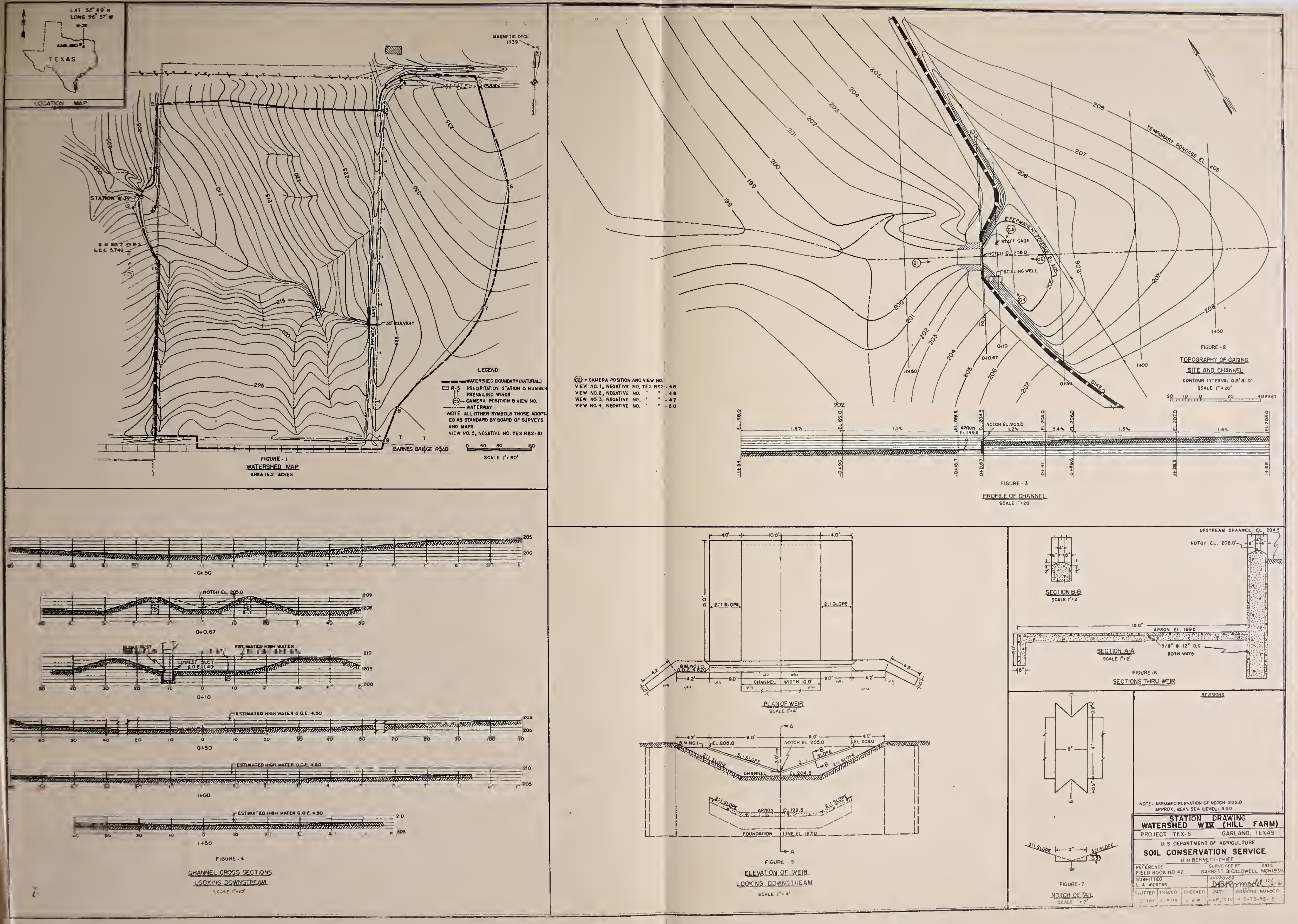


Figure 15.--Plan and construction details of a 3:1 triangular weir.

Table 5. - Discharge values for triangular weirs corresponding to various cross-sectional areas of the channel of approach 10 feet upstream from center of crest.

2:1 Weir

1-foot head		2-foot head		3-foot head		4-foot head		5-foot head		6-foot head	
Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw
Sq. ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.
6.0	5.60	13.0	41.3	26.0	132	46	270	72	500	102	900
6.2	5.58	13.2	40.6	26.2	129	47	259	73	480	103	840
6.4	5.56	13.4	40.0	26.4	127	48	250	74	464	104	790
6.6	5.54	13.6	39.4	26.6	125	49	244	75	450	105	750
6.8	5.52	13.8	38.9	26.8	124	50	239	76	437	106	725
7.0	5.51	14.0	38.4	27.0	123	52	231	77	428	107	706
7.2	5.51	14.2	37.9	27.5	118	54	225	78	420	108	692
7.4	5.50	14.4	37.5	28.0	116	56	220	79	413	109	682
7.6	5.49	14.6	37.2	28.5	114	58	216	80	408	110	675
7.8	5.48	14.8	36.9	29.0	112	60	213	82	400	112	660
8.0	5.47	15.0	36.6	30.0	108	62	210	84	393	114	647
8.5	5.45	15.2	36.4	32.0	104	64	207	86	387	116	636
9.0	5.44	15.4	36.2	34.0	102	66	205	88	382	118	627
9.5	5.43	15.6	36.0	36.0	100	68	203	90	378	120	620
10.0	5.42	15.8	35.8	38.0	98.0	70	201	95	370	125	605
11.0	5.41	16.0	35.6	40.0	97.0	72	200	100	364	130	592
12.0	5.40	16.5	35.2	42.0	96.0	74	199	105	359	135	581
13.0	5.40	17.0	34.8	44.0	95.0	76	198	110	354	140	572
14.0	5.39	17.5	34.5	46.0	94.0	78	197	115	350	145	565
15.0	5.39	18.0	34.3	48.0	93.5	80	196	120	346	150	560
20.0	5.38	19.0	33.9	50.0	93.0	82	195	125	343	160	548
25.0	5.37	20.0	33.6	55.0	92.0	84	194	130	341	170	541
30.0	5.36	21.0	33.4	60.0	91.0	86	193	140	337	180	537
35.0	5.36	22.0	33.2	70.0	90.5	88	192	150	334	200	528
40.0	5.35	23.0	33.1	80.0	90.0	90	191	160	331	220	523
45.0	5.35	24.0	33.0	90.0	89.5	100	189	180	328	240	520
50.0	5.35	25.0	32.9	100	89.0	110	187	200	325	270	514
60.0	5.34	30.0	32.5	120	88.8	120	186	230	323	300	510
70.0	5.34	35.0	32.2	140	88.6	130	185	260	321	350	508
80.0	5.34	40.0	32.0	160	88.4	140	185	300	320	400	506
		50.0	31.8	180	88.2	170	184	325	320	450	505
		60.0	31.7	200	88.0	200	183	350	319	500	504
		80.0	31.6	220	88.0	250	183	375	319	550	503
		110.0	31.6	240	88.0	300	183	400	318	600	502
		150.0	31.6	260	88.0	350	183	450	318	650	501

3:1 Weir

1-foot head		2-foot head		3-foot head		4-foot head		5-foot head		6-foot head	
Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw	Area	Discharge Qw
Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.
8.0	8.37	20.0	57.3	40.0	188	70.0	425	110	715	160	1100
8.5	8.30	22.0	54.4	41.0	180	72.0	388	115	655	162	1075
9.0	8.25	24.0	52.7	42.0	175	74.0	373	120	625	164	1050
9.5	8.22	26.0	51.5	44.0	167	76.0	360	125	605	166	1025
10.0	8.19	28.0	50.8	47.0	159	78.0	352	130	590	168	1005
11.0	8.13	30.0	50.2	50.0	154	80.0	345	135	576	170	990
12.0	8.08	32.0	49.8	52.0	152	82.0	339	140	564	172	980
13.0	8.04	34.0	49.4	54.0	150	84.0	334	145	556	174	970
14.0	8.02	36.0	49.1	56.0	148	86.0	329	150	549	176	961
15.0	8.00	38.0	48.9	58.0	147	88.0	325	155	543	178	952
20.0	7.95	40.0	48.7	60.0	146	90.0	321	160	537	180	945
25.0	7.93	42.0	48.5	62.0	145	92.0	318	165	532	185	930
30.0	7.92	44.0	48.3	64.0	144	94.0	315	170	528	190	912
35.0	7.92	46.0	48.2	66.0	143	96.0	312	175	524	200	890
40.0	7.92	48.0	48.1	68.0	143	98.0	310	180	521	210	870
45.0	7.92	50.0	48.0	70.0	142	100	308	185	518	220	856
50.0	7.92	52.0	47.9	72.0	142	105	304	190	515	230	847
60.0	7.92	54.0	47.8	74.0	141	110	300	195	512	240	838
70.0	7.92	56.0	47.7	76.0	141	115	297	200	510	250	830
80.0	7.92	58.0	47.6	78.0	140	120	295	210	508	260	822
		60.0	47.5	80.0	139	125	293	220	506	270	815
		62.0	47.5	82.0	139	130	291	230	504	280	810
		64.0	47.4	84.0	139	135	289	240	502	290	806
		66.0	47.4	86.0	138	140	287	250	500	300	803
		68.0	47.4	88.0	138	145	286	260	498	320	797
		70.0	47.3	90.0	138	150	285	270	496	340	791
		72.0	47.3	95.0	137	160	284	280	494	360	786
		74.0	47.3	100	137	170	283	290	493	380	782
		76.0	47.2	110	136	180	282	300	492	400	780
		78.0	47.2	120	135	190	281	350	490	450	776
		80.0	47.1	130	134	200	280	400	488	500	773
		85.0	47.1	140	134	250	277	450	486	550	770
		90.0	47.0	150	133	300	276	500	485	600	767
		100	47.0	200	133	400	275	550	484	650	765
		150	47.0	250	132	500	275	600	484	750	

Based on Hydraulic laboratory tests made by the Soil Conservation Service at Cornell University, Ithaca N. Y.

Table 5. - Continued

5:1 Weir

1-foot head		2-foot head		3-foot head		4-foot head		5-foot head		6-foot head	
Area	Dis-charge Qw	Area	Dis-charge Qw	Area	Dis-charge Qw	Area	Dia-charge Qw	Area	Dis-charge Qw	Area	Dis-charge Qw
Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.	Sq.ft.	C.f.s.
15.0	13.7	30	98.0	60	315	116	590	170	1070	230	1800
18.0	13.6	31	96.5	61	306	118	580	180	1015	240	1680
21.0	13.5	32	95.0	62	300	120	572	190	975	250	1615
30.0	13.4	33	93.5	63	295	122	565	200	950	260	1570
50	13.2	34	92.2	64	291	124	559	210	928	270	1530
60	13.3	35	91.2	65	287	126	554	220	910	280	1495
70	13.3	36	90.3	66	283	128	550	230	898	290	1465
80	13.3	37	89.5	67	280	130	546	240	888	300	1440
90	13.3	38	88.9	68	277	132	542	250	880	310	1424
100	13.3	39	88.4	69	274	134	538	260	871	320	1410
		40	88.0	70	272	136	534	270	864	330	1398
		42	87.2	72	268	138	531	280	858	340	1388
		44	86.5	74	264	140	528	290	853	350	1380
		46	85.9	76	261	145	522	300	850	360	1373
		48	85.4	78	259	150	518	310	847	370	1366
		50	85.0	80	257	155	513	320	844	380	1359
		55	84.1	84	253	160	510	330	842	390	1353
		60	83.5	88	249	170	504	340	840	400	1347
		65	83.0	92	246	180	499	350	838	410	1341
		70	82.7	96	244	190	494	360	836	420	1336
		75	82.4	100	243	200	490	370	834	430	1331
		80	82.2	110	240	210	487	380	832	440	1326
		85	82.0	120	237	220	485	390	830	450	1322
		90	81.8	140	234	230	483	400	828	500	1310
		95	81.6	160	232	240	481	450	826	550	1290
		100	81.4	180	231	250	480	500	824	600	1283
		110	81.2	200	230	260	479	550	822	650	1278
		120	81.0	220	229	280	477	600	820	700	1275
		140	80.8	250	228	300	475	650	818	750	1272
		170	80.6	300	227	400	470	700	816	800	1270
		200	80.5	400	226	600	465	800	812	900	1270
		300	80.5	500	226	700	465	1000	805	1000	1270

Based on hydraulic laboratory tests made by the Soil Conservation Service at Cornell University, Ithaca N.Y.

Table 6.

Discharge values in cubic feet per second for 2:1 triangular weirs for heads up to 0.70 foot applicable to stations with cross-sectional areas through intake equal to or greater than 6 aquare feet for 1.0-foot head.

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	T.	0.001	0.002	0.003	0.005	0.007	0.010	0.013
.10	.017	.021	.027	.033	.039	.046	.055	.064	.073	.083
.20	.094	.105	.116	.131	.147	.163	.179	.195	.214	.233
.30	.252	.273	.295	.318	.342	.368	.395	.423	.452	.482
.40	.514	.547	.581	.616	.653	.691	.731	.772	.814	.858
.50	.903	.950	.998	1.05	1.10	1.15	1.20	1.26	1.32	1.38
.60	1.44	1.50	1.56	1.63	1.70	1.77	1.84	1.92	2.00	2.08
.70	2.16									

Discharge values in cubic feet per second for 3:1 triangular weirs for heada up to 0.70 foot applicable to stations with cross-sectional areas through intake equal to or greater than 8 square feet for 1.0-foot head.

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	T.	0.001	0.003	0.005	0.007	0.010	0.014	0.019
.10	.025	.031	.038	.046	.055	.065	.076	.088	.101	.116
.20	.132	.149	.167	.187	.208	.230	.254	.279	.306	.334
.30	.364	.394	.427	.462	.499	.537	.577	.619	.663	.709
.40	.757	.807	.859	.913	.969	1.03	1.09	1.15	1.21	1.28
.50	1.35	1.42	1.49	1.57	1.65	1.73	1.81	1.89	1.98	2.07
.60	2.16	2.25	2.35	2.45	2.55	2.65	2.76	2.87	2.98	3.09
.70	3.21									

Diacharge values in cubic feet per second for 5:1 triangular weirs for heads up to 0.70 foot applicable to stations with cross-sectional areas through intake equal or greater than 15 square feet for 1.0-foot head.

Head	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
Feet										
0	0	T.	0.001	0.002	0.004	0.006	0.010	0.015	0.021	0.028
.10	.037	.047	.058	.072	.086	.103	.121	.141	.164	.188
.20	.215	.243	.274	.305	.340	.378	.417	.458	.500	.545
.30	.590	.640	.700	.760	.820	.880	.940	1.00	1.07	1.15
.40	1.23	1.31	1.39	1.47	1.55	1.65	1.75	1.85	1.95	2.05
.50	2.15	2.25	2.36	2.47	2.59	2.72	2.85	3.00	3.15	3.30
.60	3.45	3.60	3.75	3.91	4.08	4.25	4.42	4.60	4.79	4.98
.70	5.18									

Based on hydraulic laboratory tests made by the Soil Conservation Service at Cornell University, Ithaca N. Y.

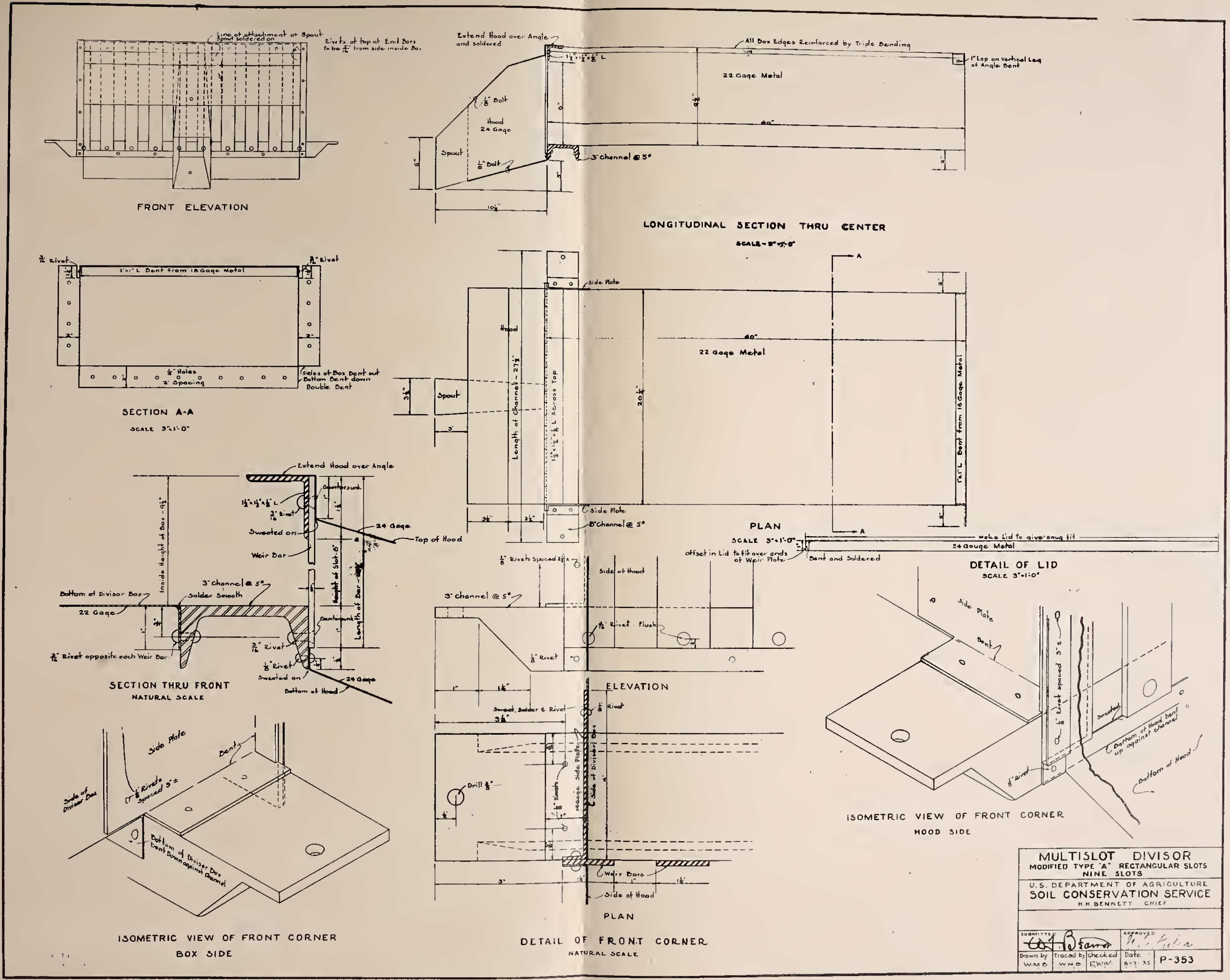


Figure 16.-Construction details of 1.0 inch multislot (9 slots) divisor

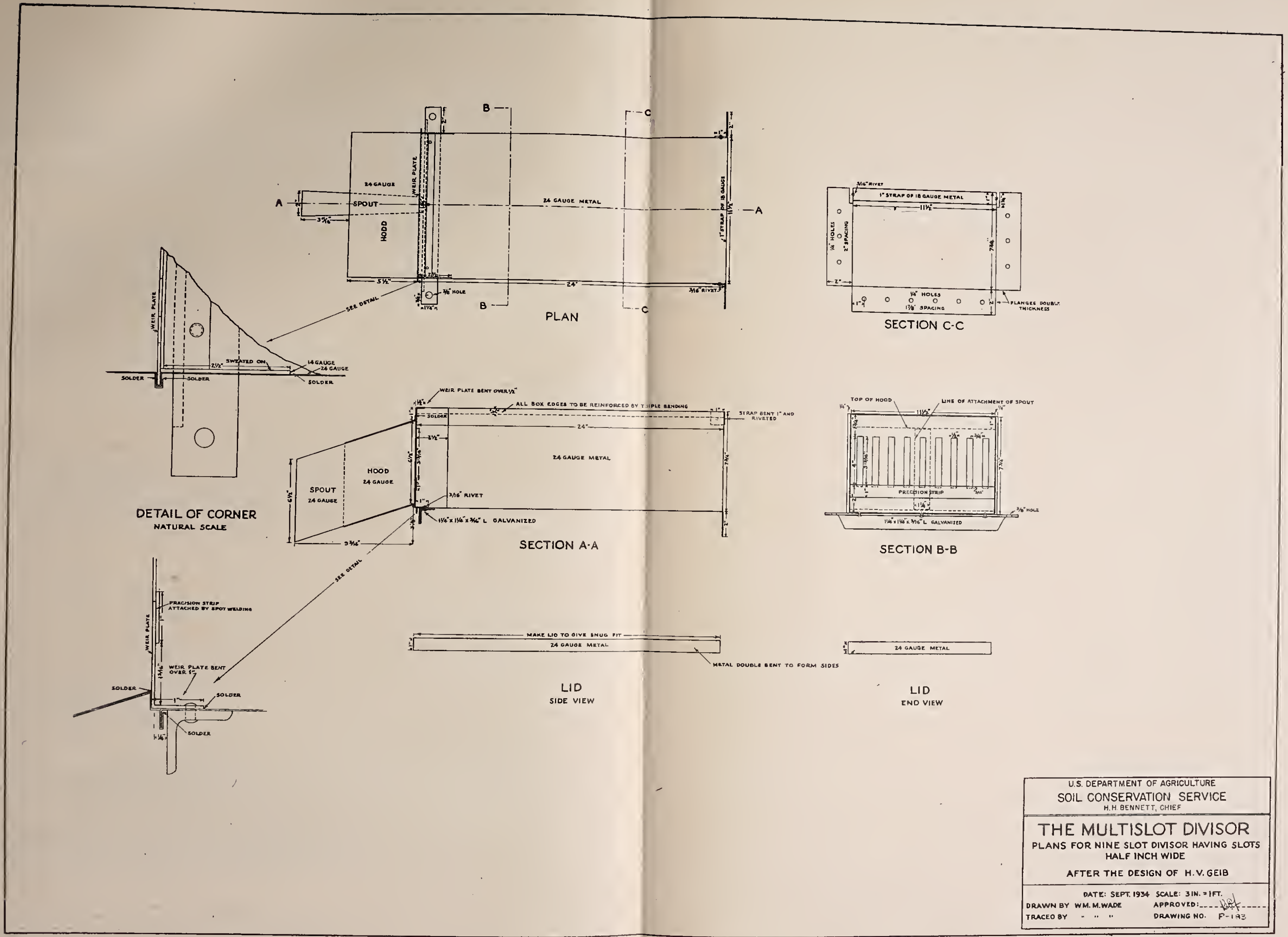


Figure 17.–Construction details of ½ inch multislot (9 slots) divisor

SPECIFICATIONS -- MULTISLOT DIVISORS HAVING SLOTS ONE-HALF INCH WIDE

Division I. General Provisions

Section 1. Definition of Terms

(a) Specifications: All provisions and requirements contained herein or on the accompanying plans which form a part hereof, together with all written or printed agreements that may be made hereafter, pertaining to the manner of performing the work or to the quantity or quality of material to be furnished under the contract.

(b) Multislot Divisor: A device for taking an aliquot of runoff water, the essential part of which is a slot plate containing several openings or slots of identical size and shape. The runoff is passed through the divisor and that portion discharged by the center slot is retained as an aliquot.

(c) Slot Plate: The metal sheet containing the slots above referred to.

(d) Precision Strip: The machined metal strip attached to the upstream side of the slot plate and forming the bottom of the slots.

(e) Spout: The sheet metal conduit attached to the downstream side of the slot plate to conduct the sample flow away from the middle slot.

(f) Hood: The protective sheet metal covering around the periphery of the slot plate on the downstream side.

(g) Divisor Box: The sheet metal box through which the runoff water is conducted to the slot.

(h) Side Plates: The sheet metal stiffening or reinforcing plates attached to the sides of the divisor box upstream from and abutting the slot plate.

Division II. Construction, One-half Inch Slots

Section 1. Materials

(a) General: All surfaces shall be of rust-resistant material.

(b) Slot Plate and Precision Strip: Both the slot plate and precision strip shall be of number sixteen (16) gage stainless steel of the kind known as 18 and 8 stainless steel.

(c) Divisor Box, Spout, Hood, and Lid: The divisor box, sample spout, hood, and lid shall be of number twenty-four (24) gage commercial galvanized sheet iron.

(d) Side Plates: The side plates shall be of number twenty (20) gage commercial galvanized sheet iron.

Section 2. Details of Construction

(a) Slot Plate: The surface of the slot plate enclosing the slots and including all thereof within one-half (1/2) inch of any slot shall not deviate from a plane by more than one-fiftieth (1/50) inch.

(b) Slots: The slots shall be square edged. They shall be four (4) inches high within one-fiftieth (1/50) of an inch and one-half (1/2) inch wide, within five one-thousandths (5/1000) of an inch.

(c) Slot Spacing: The slots shall be spaced three-fourths (3/4) inch apart within one one-hundredth (1/100) inch.

(d) Precision Strip: The precision strip shall be square-edged and the edge forming the bottom of the slots shall not deviate from a straight edge by more than five one-thousandths (5/1000) inch.

(e) Attachment of Precision Strip: The precision strip shall be electrically spot welded to the slot plate so that its top edge forms an angle with the vertical sides of the slots of ninety (90) degrees within ten (10) minutes, and so that all slot openings are three and thirteen-sixteenths (3-13/16) inches high within one one-hundredth (1/100) inch.

(f) Sample Spout: All seams in the spout and the connection to the slot plate shall be watertight. The line of the connection between spout and slot plate shall not deviate from a line bisecting the spaces between the center and the adjacent slots on each side, by more than one-twentieth (1/20) inch. The spout shall be attached before the hood is put into place.

(g) Side Plates: The side plates shall be firmly fixed to the sides of the divisor box so as to abut and be in contact with the slot plate throughout its height. The connection to the divisor box shall be made by sweating the plates on with solder or by any other method giving a waterproof connection of equal or superior strength.

(h) Solder and Tool Marks: There shall be no solder, tool marks, or other irregularities within one-half (1/2) inch of the slots on the upstream side of the slot plate nor within three-sixteenths (3/16) inch on the downstream side, except that no such irregularities shall exist within a vertical distance of three-fourths (3/4) inch below the bottom of the slots.

(i) Seams and Joints: All seams and soldered joints shall be watertight.

Section 3. Dimensions of Divisors

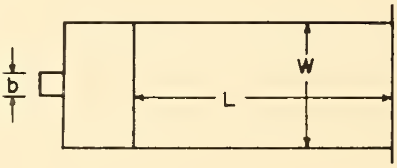
The plans accompanying these specifications are for a nine-slot divisor. The construction of divisors with different numbers of slots is to be essentially the same as shown thereon, with the exception of those changes specified in the appended "Schedule of Dimensions and Weights".

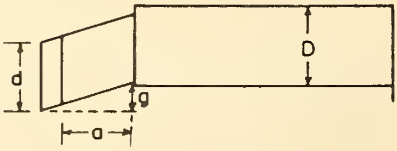
SCHEDULE OF DIMENSIONS AND WEIGHTS

for

MULTISLOT DIVISORS HAVING HALF-INCH SLOTS

SIZE			DIMENSIONS							Box metal	Approximate weight
No. of slots	Slot width	Slot height	W	L	D	a	b	d	g		
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Gauge	Pounds
3	1/2	4	4	24	7-3/4	5-1/2	2	6-1/2	3-1/8	24	12
5	1/2	4	6-1/2	24	7-3/4	5-1/2	2	6-1/2	3-1/8	24	14
7	1/2	4	9	24	7-3/4	5-1/2	2	6-1/2	3-1/8	24	17
9	1/2	4	11-1/2	24	7-3/4	5-1/2	2	6-1/2	3-1/8	24	19
11	1/2	4	14	24	7-3/4	5-1/2	2	6-1/2	3-1/8	24	21





SPECIFICATIONS -- MULTISLOT DIVISORS HAVING SLOTS ONE INCH WIDE

Division I. General Provisions

Section 1. Definition of Terms

(a) **Multislot Divisor**: A device for taking an aliquot of runoff water, the essential part of which is a slot plate containing several openings or slots of identical size and shape. The runoff is passed through the divisor and that portion discharged by the center slot is retained as an aliquot.

(b) **Slot plate**: The integral structure containing the slots above referred to. The slot-plate is fabricated from vertical bars attached to structural angles at top and bottom.

(c) **Plate Angles**: The structural angles forming the tops and bottoms of the slots.

(d) **Spout**: The sheet metal conduit attached to the downstream side of the slot plate to conduct the aliquot from the middle slot into the calibrated tank.

(e) **Hood**: The protective sheet metal covering placed around the periphery of the slot plate on the downstream side.

(f) **Divisor Box**: The sheet metal box through which the runoff water is conducted to the slot plate.

(g) **Side Plates**: The sheet metal stiffening or reinforcing plates attached to the sides of the divisor box upstream from and abutting the slot plate.

Division II. Construction, 1-inch Slots

Section 1. Materials:

(a) **Slot-plate Bars**: The slot-plate bars shall be low carbon (.15 to .25 percent) cold rolled steel. Square edge flats or their equal in respect to uniformity of dimension and sharpness of edge will be generally satisfactory, providing the tolerances hereinafter specified are not exceeded.

(b) **Plate Angles**: The plate angles shall be of best grade structural steel.

(c) **Divisor Box**: The divisor box shall be of commercial galvanized sheet iron of the gauge shown on the "Schedule of Dimensions and Weights" appended to and forming a part of these specifications.

(d) **Spout, Hood and Lid**: These parts shall be of number twenty-four (24) gauge commercial galvanized sheet iron.

(e) **Rivets**: Iron rivets shall be used.

(f) **Paint**: Where painting is called for the prime coat shall be Bakelite XE-8312 primer. The two finish coats shall be Bakelite XE-8893.

Section 2. Details of Construction:

(a) **Slot Plate**: In constructing the slot plate good machine shop practice shall be followed in all respects. The edge of the plate angle forming the bottoms of the slots shall be machined straight and shall not depart from a true straight edge by more than five one-thousandths (5/1000) inch when the divisor is completed. The legs of the angles to which the vertical bars are attached shall be straight and flat so that the upstream faces of the bars shall be in a surface departing from a plane by not more than one-thirtieth (1/30) inch.

(b) **Bars**: The bars shall be straight and attached firmly to the plate angles so as to form right angles with the edge forming the bottom of the slots. This angle shall be within fifteen (15) minutes of a precise ninety (90) degrees. The width of all bars shall be one and one-fourth (1-1/4) inches within two one-hundredths (2/100) inch. The bars may be attached by electrical spot welding or by riveting. If rivets are used those passing through the bottom plate angle shall be countersunk and finished flush and watertight.

(c) **Slots**: The slots shall have square edges and shall be one (1) inch wide throughout their heights within one one-hundredth (1/100) inch.

(d) **Sample Spout**: All seams in the spout and the connection to the slot plate shall be watertight. The line of the connection between spout and slot plate shall not deviate from a line bisecting the bars adjacent to the center slot by more than one-twentieth (1/20) inch. The spout shall be attached before the hood is put into place.

(e) Side plates: The side plates shall be firmly fixed to the sides of the divisor box so as to abut and be in contact with the slot plate throughout its height. The connection to the divisor box shall be made by sweating the plates on with solder or by any other method giving a waterproof connection of equal or superior strength.

(f) Solder and Tool Marks: There shall be no solder, deep tool marks, or other irregularities within three-fourths (3/4) inch of any slot on the upstream side of the slot plate, nor within seven-sixteenths (7/16) inch on the downstream side.

(g) Seams and Joints: All seams, soldered joints, and riveted connections shall be watertight.

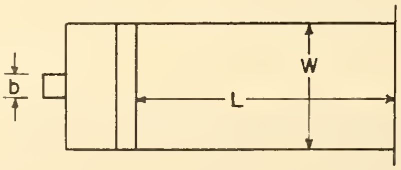
(h) Painting: After fabrication of the divisor, all exposed surfaces of the slot plate shall be thoroughly cleaned of scale, rust, and grease and given a thin prime coat of Bakelite XE-8312 primer. Two finish coats of the aluminum paint, known as Bakelite XE-8893, shall be subsequently applied, the aluminum powder being mixed with the varnish immediately before use. The paint shall be applied evenly and shall not cause the dimensions of slots or straightness of slot plate pieces to exceed the tolerances heretofore given.

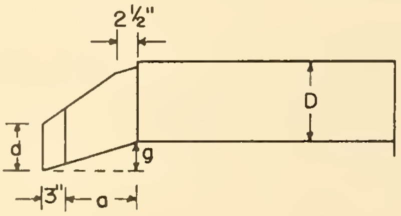
Section 3. Dimensions of Divisors:

The plans accompanying these specifications are for a nine slot divisor. The construction of divisors with different numbers of slots or with different slot heights is to be essentially the same as shown thereon, with the exception of those changes specified in the appended "Schedule of Dimensions and Weights".

SCHEDULE OF DIMENSIONS AND WEIGHTS

SIZE			DIMENSIONS							Box	Approx.
No. of Slots	Slot Width	Slot Height	W	L	D	a	b	d	g	Metal	Weight
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Gauge	Pounds
3	1	6	7-1/4	24	9	6	3	4-1/2	2-3/4	24	17
5	1	6	11-3/4	24	9	6	3	4-1/2	2-3/4	24	23
7	1	6	16-1/4	32-1/2	9	6	3	4-1/2	2-3/4	22	35
7	1	8	16-1/4	32-1/2	11	7-1/2	3-1/4	5-1/2	3-1/4	22	43
9	1	8	20-3/4	40	11	7-1/2	3-1/4	5-1/2	3-1/4	22	55
11	1	8	25-1/4	40	11	7-1/2	3-1/4	5-1/2	3-1/4	20	68
11	1	12	25-1/4	40	15	10-1/2	3-3/4	8	4-1/4	20	85
13	1	12	29-3/4	40	15	10-1/2	3-3/4	8	4-1/4	20	95
15	1	12	34-1/4	40	15	10-1/2	3-3/4	8	4-1/4	20	100





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